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Getting a Grip on
Maintenance Management
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Comment

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Recent reports on the possibility of hostilities in Europe confirm that NATO defense plans must be strengthened. The potential aggressor is capable of launching an attack within a very short build-up time. Because NATO forces cannot depend on an extended warning, they must be prepared to fight with whatever weapons are available and ready. To the logistician this means that the supplies must be available in the right places, and that the transportation system and the combat equipment must be maintained in a state of readiness to permit immediate response to any aggression. The global situation indicates that the readiness needs are not limited to NATO obligations, but apply to the United States' military commitments worldwide.

Modern maintenance technology, training, and management systems have resulted in the best national defense maintenance capability to date. Even as that capability has improved, however, increased complexity of weapon systems and the compressed time available for response have increased the maintenance burden. Thus, the innovations that have created today's maintenance capabilities must not only continue, but must be followed by more if maintenance is to respond to changing readiness requirements.

To assure effective implementation and attainment of projected economies, sufficient management attention must be directed at ongoing programs for improving maintenance management. Reliability-Centered Maintenance, fashioned to increase readiness and decrease costs, needs to be aggressively pursued. Integrated Logistics Support Planning, designed to control downstream maintenance workloads and costs, warrants particularly close attention.

Efforts to obtain reliable cost and production information on maintenance endeavors must proceed, since knowledge of the current conditions is essential to planning for improvements. In addition, the reliability of materiel readiness data must be improved.

There are also many relatively untouched management policies and procedures that could yield further improvements. Among them are:

- Reexamination of the repair versus discard decision processes.
- Expanded management responsibility for base-level resources, including items now considered "free" because repair is funded at depot level.
- Reexamination of separately created maintenance management information systems which, while they have some common objectives, inhibit interchange of information among services.
- Greater visibility of maintenance resources in the 5-year defense plan.
- Better capabilities to predict and update maintenance workloads and resource requirements based on established scenarios.

Although change can be upsetting, it can also be productive. Today's innovations resulted from change. The market for new ideas is open. Maintenance management must continue to be improved if equipment readiness needs are to be satisfied. At the same time, maintenance costs must be controlled, thereby assuring that funds will continue to be available to modernize our weapons and improve our capabilities. DMJ

DoD Maintenance Management

"It Isn't the Cost; It's the Upkeep"

Today, DoD must put as much attention into management of the resources consumed in maintaining weapon systems and equipment as it does into the acquisition process.

One has only to read the daily newspapers to become generally familiar with the flow of new weapon systems being acquired by the Department of Defense. Who has not heard of the latest aircraft and ships under development or being introduced into the military departments? They include the F–14, F–15, F–16, B–1, AWACS and UTTAS, the Trident submarine, and the Nimitz-class nuclear-powered aircraft carrier. News accounts, within the limits of security, discuss the new capabilities and technological breakthroughs represented or reflected by each new system. The media place even greater emphasis on the high and sometimes escalating cost of acquiring these systems. Little or no mention is made, however, of the cost of maintaining the weapon system over its life—a cost which in many cases can exceed that of acquiring the system.

by Joseph G. Turke
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"It isn't the cost; it's the upkeep." That expression has been around a long time. At one time it was applied to the relative cost of acquiring a wife—the $2.00 license fee—versus the cost of supporting a wife. This, of course, was before a large proportion of wives joined the work force. Now the expression can more often be heard in discussions that involve the purchase of a horse, an automobile, or a boat, or having children. In our everyday lives we recognize that certain actions carry simultaneous long-term commitments for upkeep, and plan accordingly. The size of that commitment is not always known at the outset, so it becomes a continuing task to control the cost as long as the commitment endures.

The Department of Defense is no different with regard to its weapon systems and equipments. The task is simply on a larger scale because of the very size of the weapon system in-

ventory and the variety of individual items in terms of types and models, technologies involved, and degrees of complexity and age. Since many weapon systems will remain in use for 20 or 30 years, the mixture of older and newer technologies can pose special problems. Each new system or equipment introduced into the inventory will require maintenance at some time during its service life. Because each system, by reason of its design characteristics, has discrete requirements, maintenance management must be oriented accordingly.

Maintenance Defined

In total terms, equipment maintenance in the Department of Defense includes all maintenance performed on weapon systems and other equipment. Maintenance tasks range from routine oil changes through inspections, calibrations, and component replacement, up to complete rebuilding of components or the end item.

The least complex tasks are often performed by the equipment operator as a part of his normal duties. The more complicated ones are performed at the operating-unit level by military, DoD civilian, or contract specialists. The most complex work, referred to as depot maintenance, is accomplished by DoD depot maintenance and contractor facilities. Equipment maintenance encompasses, as an essential part of its management function, the technical capabilities and information systems needed to analyze equipment performance, identify desirable modifications, and provide direction to actual maintenance operations.

The purpose of equipment maintenance is to keep DoD weapon systems and other end items in a state of operational readiness to meet mission requirements, and to do this at minimum cost. This places maintenance in a critical role in defense planning and operations.

For maintenance to do its job successfully, it must ensure that the equipment is available and

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capable of performing its peacetime and wartime missions. This involves supporting an inventory of equipment, in use and assigned, that on July 1, 1976, had an acquisition cost of $126 billion (see Figure). It involves equipment in all military services and includes all categories, from aircraft, missiles, and ships, to construction equipment, generators, and communication equipment.

Historically in DoD, management of the equipment maintenance function was the responsibility of research and engineering. In 1959, the Office of Maintenance Policy was established within the Office of the Assistant Secretary of Defense (Supply and Logistics). The functions assigned at that time were essentially the same as they are today and related both to maintenance engineering (the technical aspect of maintenance) and maintenance production (the actual accomplishment of the maintenance).

Emphasizing Maintenance

The key role of the equipment maintenance function was emphasized in 1962 when the Office of Maintenance Policy was assigned to the Deputy Assistant Secretary of Defense (I&L) (Equipment, Maintenance, and Readiness). Subsequently, in view of the close interrelation between maintenance and supply, the office was redesignated the Directorate for Maintenance Policy and was transferred to the DASD (I&L) (Supply, Maintenance, and Services).

Assumption of responsibility for maintenance policy by the ASD (S&L) in 1959 was particularly important. It gave recognition to the significant cost of equipment maintenance, both in absolute terms and as a percentage of the defense budget involving capital investments as well as annual consumption of resources. It indicated DoD's awareness of the need and the potential for reducing these costs through improved management. While each of the military services was acting to accomplish this, a coordinated approach, directed and supported by DoD, was expected to accelerate benefits. Viewed another way, while the need to manage the technical aspects of equipment maintenance received continuing recognition, major emphasis was given for the first time at DoD level to management of resources consumed in maintaining weapon systems and equipment.

Today, the Secretary of Defense provides policy and guidance to the military services for their maintenance programs, reviews service implementation of those policies, and examines service requests for funds and other resources to assure that the requests are adequate but not excessive to achieve the approved programs.

Each military department is responsible for maintaining its weapon systems and equipment in accordance with policies established by the Secretary of Defense. Annual planning and program guidance from DoD defines the wartime planning scenario and provides criteria for readiness planning by the military services. From this guidance, the services develop their annual budget submissions, which include requests for the personnel and funds necessary to maintain weapon systems in a satisfactory, ready condition.

Cost Factors

Each year, maintenance and related costs consume about 20 percent of the DoD budget. As part of this, for fiscal year 1978 a total of $6.5 billion was requested for depot maintenance alone. Approximately 70 percent of that work will be accomplished in organic facilities and 30 percent in the commercial sector. The portion of the work accomplished in DoD-owned and -operated activities will require over 150,000 civilian employees.

The specific cost of maintenance done at unit level (below depot), which accounts for most of the total expenditure, is elusive. Manpower and other resources utilized for maintenance at unit level are also utilized for other tasks associated with normal operations. Funds for maintenance come from many appropriations, such as military personnel, operations and

maintenance, procurement, and military construction. In addition, many of the resources ultimately expended for maintenance are initially identified to such other areas as military manpower, supply, transportation, and so forth. For example, it is not easy to separate the material and labor costs devoted to the maintenance of a ship by its operating crew while the ship is underway.

Nevertheless, a reasonable estimate places the cost of the resources consumed annually in depot- and unit-level maintenance of weapon systems and equipment at about $18 billion to $20 billion, including spares, repair parts, and modifications to improve system capability.

There are many variables impacting the cost, effectiveness, and size of the DoD maintenance program. Two of the most basic are:

- The amount of maintenance that must be done to sustain the item in a ready, safe, and reliable condition.
- The efficiency with which necessary work is performed.

DoD policies for equipment maintenance are directed at both these variables and are structured to control and possibly reduce the demand for maintenance; and to ensure that necessary maintenance is performed as efficiently as possible.

The overall policy guidance to reduce demand and optimize performance is provided in Department of Defense Directive 4151.16, "DoD Equipment Maintenance Program." The document contains twenty-four individual policy statements. Among other things, these policies call for:

- Orientation of management upon weapon and equipment end items as systems (as opposed to commodity groupings).
- Full participation of maintenance engineering activities in all phases of the life cycle of weapon and equipment end items to assure a balanced logistic support program.
- Management of maintenance production operations on the basis of total cost, using uniform cost accounting and production reporting systems appropriate to the level of maintenance.
- Development of automated programming systems to assure currency between maintenance programs, force structure, and operating plans.
- Consolidation of maintenance activities where economies can be expected without adversely impacting operational commitments.
- Use of interservice support.
- Sizing organic depot capabilities and capacities on the basis of approved, mission-essential workloads.

All of the policies are intended to contribute to the objective of equipment maintenance, which is to sustain weapon and equipment end item systems, at the least total cost, in a state of operational readiness consistent with the mission requirements of the operating and tactical elements.

Weapon Systems And Equipment In Use Or Assigned
(Billions of Dollars At Acquisition Cost)
July 1, 1976

By Military Department		By Weapons Group	
Army	19.2	Aircraft	54.1
Navy and Marines	61.7	Ships	38.8
Air Force	45.3	Missiles	8.7
	126.2	Vehicles	9.0
		Other	15.6
			126.2

Integrated Logistic Support

It is generally accepted that when a new weapon system enters initial production, 80 percent or more of future maintenance requirements have been locked in as a consequence of the design. Nevertheless, until recent years, future maintenance demands received relatively little management attention during the design phase. Optimizing performance, schedule, and acquisition cost received much higher priority than was given to designing the equipment to reduce downstream maintenance needs. In some cases, it appeared to the ultimate user that future maintenance needs were not even considered in equipment design and acquisition.

In the early 1960's, it was perceived that the largest single improvement on maintenance workloads and cost could be achieved by designing equipment for minimum practical maintenance. Although the benefits would not accrue for several years because of the lead time involved in acquiring new weapon systems, the fact that the potential downstream benefits

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would be large made this concept a matter of highest priority. Capitalizing on some earlier individual efforts by the services, the Directorate for Maintenance Policy sponsored a joint task group to develop a new DoD policy to provide guidance in this area.

DoD Directive 4100.35, "Integrated Logistics Support Planning," issued in June 1964 and reissued in 1970, took a big step toward reducing maintenance demand by requiring the development of detailed support plans for new systems and the projection of support costs over the useful life of the system. This was to be accomplished concurrently with the development of the weapon system to assure that the system could be supported at an acceptable cost. Implementation was slower than desired as both defense and contractor personnel attempted to understand and apply the new policy. However, the awareness of the magnitude of support costs persisted, leading to the current emphasis on the life cycle during design and acquisition.

When integrated logistic support planning is discussed, emphasis is usually placed on achievement of anticipated lower support costs. However, the increased reliability and maintainability necessary to produce those lower costs will, at the same time, improve the availability or readiness of the system. While not generally quantified in dollars, this improvement is at least of equal importance to dollar savings.

Reliability-Centered Maintenance

A more recent effort at controlling the demand for maintenance is especially promising. Referred to in DoD as reliability-centered maintenance, it is essentially an adaption of the maintenance approach developed by commercial airlines. It is based on the fact that equipment design determines maintenance requirements. Maintenance actions can only sustain the equipment at or restore equipment to its designed level of reliability.

This strategy requires that an engineering analysis of the specific equipment be performed to identify the risk of failure of a particular component, the feasibility of detecting impending failure, and the efficiency of alternative maintenance actions. Through a sequence of "logic" steps, maintenance actions that contribute to retaining or restoring equipment reliability are identified and scheduled. Other maintenance actions are eliminated.

With these analysis techniques, the airlines were able to significantly reduce scheduled inspections, removals, and repairs without adversely impacting their excellent safety record. Corresponding reductions were achieved both in the cost of scheduled maintenance and in equipment downtime.

The Naval Air Systems Command took the lead for DoD in applying the concept to aircraft. Within DoD guidelines, it is now being applied by all the military services not only to aircraft, but also to ships, combat and tactical vehicles, and other equipment. The benefits anticipated from implementation of reliability-centered maintenance include increased availability of weapon systems and reduced cost of support.

The combination of integrated logistic support and reliability-centered maintenance shows great promise. A system design and a good ILS plan to reduce downstream maintenance needs, followed by a realistic RCM plan with continual analysis of performance to avoid unneeded inspections or removals, can be expected to reduce costs and increase readiness. Both recognize the design impact by designing for minimum maintenance and doing only the scheduled maintenance required by the design.

Cost Visibility

A major deterrent to improving the efficiency of equipment maintenance operations has been the lack of visibility of cost and production. While individual units could initiate particular cost-saving actions based on their perception of costs, there was no easy way to compare the cost of alternative solutions which involved other units. Thus, questions of concern

to the military departments and DoD usually required ad hoc study efforts instead of being routinely handled at lower levels of management. The answers sought included, for example, the relative cost of repairing or replacing an item, the cost differences for the same work among depots within and among services or between organic and contract sources, the cost impacts of alternative distribution of workloads, and the results of programs undertaken to reduce costs.

The lack of uniform or standard cost accounting systems among activities engaged in maintenance leaves management at all levels without a basic tool. The unit doing the maintenance is without the capability to evaluate consistently the cost aspects of its performance. Perhaps equally important, neither the unit doing the work nor higher echelons of management can realistically identify the maintenance operations that are good cost performers and those that need improvement.

Progress is being made in this area as regards depot maintenance. The Department of Defense Depot Maintenance and Maintenance Support Cost Accounting and Production Reporting Handbook (DoD 7220.29H) has been issued to standardize depot maintenance production cost accounting. A pilot test by the Air Force is under way to develop similar cost information for maintenance below depot level.

In both cases, costs will be identified not only to the performing activity and the item repaired, but also to the weapon system being supported. Development of maintenance costs under these programs will be important to the development of credible operating and support costs.

Mere knowledge of previous years' performance and costs does not produce savings. Savings occur by applying that knowledge to future maintenance programs to achieve maximum cost effectiveness. This is particularly true of investments in test equipment, shop equipment and facilities, where lead time from initial concept to beneficial use can exceed 3 years. Personnel acquisition and training can also require 1 to 3 years to develop new skill cadres, and planning must be continually updated. For example, DoD requires a 5-year plan of projected facility investments.

Another benefit of improved cost and production reporting is improved planning for

depot maintenance requirements. Better planning permits better identification of the DoD and contractor depot maintenance capabilities and capacities necessary to meet contingency requirements and yet operate efficiently in peacetime. Based on DoD guidance (DoDI 4151.15), each of the military departments is currently engaged in improving depot maintenance programming capabilities with emphasis on automated systems. These systems will facilitate keeping the plan current with force structures and operating programs, and will permit examination of alternative workload distribution plans in terms of effectiveness and cost.

The development of new systems to provide management the needed visibility at all levels is essential and is an item of high priority. It also takes time. In the case of an organization as large as DoD, implementation can extend over several years.

No one doubts that the aircraft, ships, and other weapons acquired by DoD in the past 15 to 20 years are substantially different from earlier versions. The introduction of such new developments as the gas turbine engine, nuclear power, vastly expanded application of electronics, longer range and higher speeds for aircraft, and the improved ability to move equipment by air indicated that examination of the equipment maintenance base would reveal significant potential for savings. This was particularly significant in view of the high investment required to establish modern maintenance capabilities, particularly at depot level.

Studies by OSD, the Joint Logistics Commanders, and the individual military departments have resulted in savings by consolidating maintenance facilities within military departments, consolidating maintenance workloads across services through the use of interservice

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support agreements or single manager assignments, and using contractor support where this proved cost-effective.

As a result of these activities, the depot maintenance complex today is significantly different from that which existed 15 years ago. In that time the Army has discontinued depot maintenance activities at 25 locations in the United States and consolidated workloads into 8 locations for greater efficiency. The Navy has closed 3 naval shipyards and a naval air rework facility, while the Air Force closed 3 aeronautical depots in the 1960's. Consolidation of workloads permitted concentration of new investments in modern, efficient equipment and facilities to support increasingly complex weapon systems.

A unique approach to the consolidation of depot workloads within a military service was implemented by the Air Force in 1973 and 1974. Component workloads were identified with the technology represented and the skills and equipment required to repair them. In most cases, a single repair capability was then established for each technology at one of the six Air Force depot repair activities. These were designated as technology repair centers. With few exceptions, all work for repair of components was then concentrated at the designated TRC to obtain the benefits of volume. The Air Force has identified annual savings of over $13 million from application of the TRC concept.

Interservice Support

Other consolidations involve the use of interservice support. Interservicing, where one military service accomplishes work for another, is much more common today than in years past. Through interservicing, the Air Force now provides depot overhaul for both its own and the Navy's TF–41 engines used in the A–7 aircraft. The Navy will overhaul versions of the TF–34 engine applicable to the Navy S–3A and to the Air Force A–10 aircraft.

The Joint Logistics Commanders have also been coordinating an extensive review of existing workloads, and a number of additional interservice support agreements have resulted. However, the major opportunity for interservice support lies with new systems being introduced into the inventory. To meet this challenge, the Joint Logistics Commanders have agreed to establish a small, joint activity to review the depot maintenance requirements of these new weapons and assure maximum use of interservice support.

Another promising area is the use of total contractor support for selected aircraft. This is particularly applicable to training aircraft,

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which normally are not deployed. Currently contracts are in existence for the C–9 aircraft, a medical evacuation version of the DC–9, and the T–43A, a navigator training version of the Boeing 737. Experience with these aircraft trends will assist in decisions on the future use of this alternative.

One area of improved maintenance performance has had the added benefit of reducing demand. The introduction of automated test equipment, nondestructive testing, and better production control systems are examples. These techniques confer a twofold benefit; they not only improve performance efficiency, but often eliminate the need for some tasks to be performed at all.

Few of these improvements were inexpensive. The automated equipment, which generally has a high acquisition cost, forced a situation of spending more now to reduce costs later. Nondestructive testing also often requires an initial investment.

Production control system improvements included the controversial innovation of removing maintenance from the control of the operator and centralizing it under a maintenance-oriented manager. Although at first the benefits seemed doubtful, centralized control of maintenance has improved readiness and reduced cost in many components of DoD.

Another trend involves increased use of computer programs to forecast workloads and personnel and resource requirements, and to match capabilities to scenarios. The computer programs simplify the problem of forecasting the impact of a change in the variables affecting maintenance capability.

Keeping Objective In Sight

In an area such as equipment maintenance, which is critical to readiness and which offers a continuum of opportunities to improve both technical and production performance while reducing costs, there is always a risk that managers will redouble their efforts but lose sight of the objective. The objective is readiness at least cost. If the equipment is not maintained in a ready state, then the equipment is of little value. The "least cost" part of the objective must hold equal weight with, but not overshadow, readiness.

In peacetime, it is easy to think of maintenance as purely a business and to search for the most cost-effective means of achieving peacetime goals. This is generally a sound approach, so long as maintenance does not become so cost-effective that it cannot expand and flex with the wartime requirement. Current actions within the Department of Defense are designed to ensure that wartime readiness is retained as the primary objective. The annual planning and programming guidance officially states this requirement to the service planners.

Additionally, DoD maintenance policy related to the use of contractor and organic facilities as addressed in DoD Directive 4151.1 is currently being reviewed to eliminate any doubt of the importance of readiness. Simply stated, the policy requires peacetime readiness support with the capability to expand to meet the wartime requirement, and to meet these criteria at the least total cost.

The Department of Defense and the military departments individually and jointly are exploring every opportunity to improve the management of equipment maintenance. It is important that these efforts continue to assure that we can afford to operate the equipment we own. DMJ

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Handbook is the Key

Tracking the Costs of Depot Maintenance

The new depot maintenance cost accounting system cuts across appropriation accounts and collects maintenance-related costs regardless of how the costs are financed.

Historically, there has been a lack of capability to ascertain accurately the total costs involved with the equipment maintenance function. Difficulties become more pronounced when an attempt is made to determine the cost of maintaining particular weapon systems. Even at the depot level, where maintenance costs are more visible than at the organizational and intermediate levels, there has been considerable difficulty in determining costs and in attempting to compare the costs of different activities performing similar work on the same types of items.

In the past, when cost data was required, special studies were conducted because there was no reliable system which routinely collected the total cost of the maintenance function identified to the weapon system supported. These studies often produced inconclusive results because there was no auditable system covering all aspects of the maintenance function from which to extract source data.

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It would be rare indeed to find a commercial concern where management does not know, at least to some reasonable approximation, what it costs to produce the products or services which provide the lifeblood of the organization. Why, then, does the Department of Defense not know routinely what it spends in carrying out the maintenance function, particularly at the depot level? The question cannot be answered merely by noting the absence of a profit motive. Other factors must be considered to appreciate why cost determinations have been so elusive. There are two major difficulties involved:

- The problem of accounting for product or functional costs when such costs are financed through a number of different appropriation accounts.
- The lack of comparability in the treatment of costs between installations of different military departments or even among installations within a single department.

Funding

Like other federal agencies the Department of Defense receives its funds from Congress, which authorizes DoD to obligate funds held by the Treasury through the passage of public laws known as appropriation acts. The basic funding unit is the appropriation account, which is an allocation of money that can be spent only for a specified purpose under the law. The fiduciary accounting system, therefore, tracks funds by appropriation account.

No single appropriation account totally finances the maintenance functions. Civilian personnel salaries and consumable material involved in the maintenance effort, for example, are generally funded from operation and maintenance accounts. Military personnel accounts pay the salaries of military personnel; procurement accounts provide for the cost of centrally managed and procured material and industrial plant equipment; and military construction accounts fund the cost of erecting maintenance facilities. Hence, if the costs of maintaining weapon systems are to be captured routinely, it must be through a system that crosses a number of appropriation accounts and collects maintenance-related costs regardless of how such costs are financed.

Lack of Comparability

In addition to the problem of determining the cost of a product or function financed through multifunding sources, there has also been difficulty in comparing costs between installations because of a lack of uniform treatment of costs. A 1971 General Accounting Office audit report on depot maintenance cost accounting revealed that cost accounting practices varied so widely among services and even among activities within a single service that no meaningful comparisons of activities performing similar work could be made.[1] Some of the inconsistencies noted by GAO were:

- The parameters of maintenance were not defined consistently among services or among depot maintenance activities within a single service. As an example, some activities considered preservation, packing, depreservation, and unpacking part of the maintenance process, whereas others did not.
- Repairable components (also called exchange material) used in the overhaul or repair of end items were costed by different methods and at varying amounts between the services.
- Indirect expenses were not consistently categorized between the services.

Basic System Differences

The Army and Navy use a job order cost accounting system under which direct material, direct labor, other direct costs, and a calculated share of overhead are charged to a unit or quantity of units which flow through the maintenance process as a continuously identifiable unit or group of units. Job order cost accounting systems are generally used in job shop-type operations.

The Air Force, which is converting to a job order cost accounting system, currently uses a standard process cost accounting system. This system is generally used in industrial organizations where each department or cost center produces a single product or a limited number of products.

In the Air Force system, actual costs are accumulated by organization (resource control center) rather than product. Labor costs are accumulated at resource control centers and compared periodically with standard costs for the tasks completed to determine the efficiency ratio for the resource control centers. The labor hours required to repair an item are computed by adjusting the predetermined labor standard through the application of an efficiency factor. Therefore, the validity of maintenance costs computed under this system is largely dependent upon the accuracy of the standards and the validity of the assumption that there is equal efficiency across all workloads within a resource control center. Such a center can involve well over 100 persons and many different operations and standards.

Toward a Uniform System

There have been attempts to establish a uniform cost collection system for depot maintenance activities since 1963, when DoD Instructions 7220.14, "Uniform Cost Accounting for Depot

[1] *General Accounting Office, Comptroller General's Report to the Congress, "Potential for Improvements in Department of Defense Maintenance Activities Through Better Cost Accounting Systems" (B–159797), Washington, DC, February 2, 1971.*

Maintenance," and 7720.9, "Depot Maintenance Production Report," were issued. In 1968, both were consolidated in DoD Instruction 7220.29, "Uniform Depot Maintenance Cost Accounting and Production Reporting System," issued jointly by the Assistant Secretary of Defense (Comptroller) and Assistant Secretary of Defense (Installations & Logistics). The primary objective was to account for all maintenance costs regardless of the method of financing and to identify maintenance costs to the weapon systems supported.

There were three fundamental reasons for the inconsistent and questionable costing practices that existed despite the instructions cited in the preceding paragraph:

- Due to a lack of specificity in the DoD instruction, many costing practices were not covered, and those that were covered were subject to varying interpretations.
- There was not adequate enforcement of the policies or practices that were enunciated in the instructions.
- The prescribed systems were not integrated with a controlled accounting system.

"Depot maintenance has been estimated to be about one-third of the total maintenance effort."

The GAO report previously mentioned noted the first two reasons and recommended that the Secretary of Defense issue instructions that would ensure that cost accounting systems provide complete, comparable, and accurate information on the operation and accomplishment of depot maintenance.

The Act of 1950

The Budget and Accounting Procedures Act of 1950 requires that the accounting systems of federal agencies conform to the accounting principles, standards, and related requirements prescribed by the Comptroller General (the chief executive of the GAO). In compliance with this requirement, the Assistant Secretary of Defense (Comptroller) submitted DoD Instruction 7220.29 to GAO for approval of the accounting principles and standards contained therein. After an extensive review of the instruction and of actual procedures at various Army, Navy, and Air Force depot maintenance activities, GAO sent a letter to the Secretary of Defense withholding approval of the accounting principles and standards in the instruction primarily because the system was not integrated with a controlled accounting system and therefore lacked assurance of data reliability.[2]

The Handbook

In November 1972, the Assistant Secretary of Defense (I&L) formalized a joint logistics commanders' panel to create a depot maintenance cost accounting manual which would provide more definitive instructions and be integrated with a controlled accounting system, thereby increasing the comparability and validity of cost and production data. The JLC panel surveyed numerous depot maintenance activities, noted various inconsistent costing practices, and recommended detailed uniform costing guidance. It was primarily this effort that led to the publication, in October 1975, of the "Department of Defense Depot Maintenance Cost and Maintenance Support Accounting and Production Reporting Handbook."

"Why, then, does the Department of Defense not know routinely what it spends in carrying out the maintenance function, particularly at the depot level?"

In August 1975, the Deputy Secretary of Defense directed that the implementation of the handbook (then in draft form) be expedited through pilot installations at selected activities. He also established a working group to provide assistance in developing individual service implementation plans and to monitor the pilot installations. The working group identified a number of problem areas which were taken into consideration in the official issuance of the handbook and in the first change made to it.

The uniform depot maintenance cost accounting system prescribed by the handbook was implemented at all Army, Navy, and Marine Corps depot maintenance activities on October 1, 1976. The Air Force has experienced difficulties in converting to an adequate job order cost accounting system and plans full

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[2] *General Accounting Office, Letter from Daniel Borth, Deputy Director, to the Secretary of Defense, Attention: Assistant Secretary of Defense (Comptroller), dated January 21, 1971.*

implementation by October 1979.

The principal objective of the handbook is to establish a uniform cost accounting system for use in accumulating the costs (regardless of how such costs are financed) of depot maintenance activities as they relate to the items maintained and weapon systems supported. The handbook does two important things that have not been done previously:

- It requires that the system, which spans several funding sources, be controlled by a double-entry, accrual-based general ledger accounting system.
- It prescribes more specific and detailed accounting criteria than any previously issued DoD guidance regarding depot maintenance costing.

The following are examples of detailed handbook guidance addressed to the correction of specific deficiencies:

- The parameters of depot maintenance costing are presented to achieve uniformity in determining what will be included in depot maintenance product costs in a maintenance/supply environment.
- The average cost to repair is defined as the costs reported for exchange material maintenance in the work performance categories "overhaul" and "repair."

"With the implementation of the handbook at Army, Navy and Marine Corps activities in FY 77, a significant step has been taken in obtaining cost visibility at the depot level."

- More precise definitions for direct and indirect cost elements are provided than were presented in the previous edition of DoD Instruction 7220.29.

The Data Bank

The handbook requires each military department to maintain, in a central location, a magnetic tape prepared in accordance with the magnetic tape layout and instruction it provides; to update the tape quarterly on a cumulative basis; and to submit it to DoD at the end of each fiscal year. Since the system was initially implemented for fiscal year 1977, the first tape will be submitted following the end of this fiscal year. The magnetic tape will identify each system, subsystem, or component item worked on as a programmed depot maintenance workload; the activity performing the work; the customer for whom the work was performed; and the weapon or support system which the item supports.

The depot maintenance costs are categorized into the basic cost elements: direct labor, direct material, other direct costs, production overhead, and general and administrative expense. There are some special cost elements to accommodate special cases; for example, a direct material cost element designated "government-furnished material" allows separate identification of material furnished by the government to contractors. All of the data are categorized both by the nature of the work performed and the type of hardware the work is performed upon. The type of work is represented by the work performance category such as overhaul, repair, modification, and so forth. The hardware the work is performed upon is described by the work breakdown structure.

The data bank contains certain costs not universally considered maintenance costs; for example, the cost of modification kits as well as the cost of labor to install the kits is included.

"The depot maintenance costs are categorized into the basic cost elements: direct labor, direct material, other direct costs, production overhead, and general and administrative expense."

The DoD acquisition community considers the labor costs incurred at DoD-owned and -operated depot maintenance activities as maintenance costs, but the costs of the modification kits as investment costs.

The cost elements of the data bank were designed to accommodate various users of the data. The establishment of a separate, distinct, direct material cost element for the cost of modification kits allows users of the data to extract those costs, if desired. It also allows those within the acquisition community with responsibility for modification management to see readily the cost of modifications put in place in a given year by weapon system or subsystem, service, and individual activity.

The chief advantages of the data bank required under the handbook's system over the one established under the 1968 version of DoD Instruction 7220.29 are:

- The data contained in the new data bank will be more complete, accurate, and comparable

among all depot maintenance activities.

• Total costs will be subdivided into funded and unfunded categories, thereby making the data more useful in the budgetary process.

• Some additional cost elements, such as the one for cost of modification kits, have been added.

Using the Data Bank

When the data bank emerges as a reality at the end of FY 77, it will become the source for historical depot maintenance cost information used in meeting informational needs of various managers engaged in all phases of a weapon system's life cycle. As the need for cost and production information arises relating to particular problems, there will be a reliable data bank from which information may be readily obtained. On a routine basis, summaries may be compiled to meet gross informational needs of various management levels in the form of periodic reports. Also, exception reporting may be established on a routine basis.

"Historically, there has been a lack of capability to ascertain accurately the total costs involved with the equipment maintenance function."

The uses of the information gained under this system to managers involved with the maintenance function are obvious. Comparisons between organic and contractor maintenance accomplishment, in-house activities of different services or even within the same service, and repair costs versus replacement costs will become viable without the initiation of special studies. An example of a routinely producible exception report is the identification of items repaired at two or more depot maintenance activities and the appropriate cost data involved.

"The uses of the information gained under this system to managers involved with the maintenance function are obvious."

This will allow cost comparisons between activities performing similar work and identify cases to be examined for possible duplication of effort and facilities. There will always be cost variances among activities; but those variances, under the uniform system prescribed by the handbook, should be due to differences such as work specifications, efficiency, or plant layout —not to differences in the way costs are accounted for.

Perhaps less obvious is the value of the data to persons outside the maintenance area. Selected data from this data bank can make a significant contribution to the knowledge and planning of those engaged in research and development and acquisition. Although historical, the data bank will be of considerable value to the process of projecting future maintenance requirements of new weapon systems under development. As an example, a program manager developing an integrated logistic support plan for a new weapon system containing various electronic subsystems already in use in existing weapon systems will be able to tap into the data bank and ascertain where the depot maintenance of these components is presently being accomplished, not only in his own service but in the other services and commercially as well, and what it costs at each place.

A Concluding Note

With the implementation of the handbook at Army, Navy, and Marine Corps activities in FY 77, a significant step has been taken in obtaining cost visibility at the depot level. It should be noted, however, that depot maintenance cost and production data alone do not portray a complete picture of weapon systems maintenance. The shifting of the maintenance workload between levels of maintenance alters that picture. Depot maintenance has been estimated to be about one-third of the total maintenance effort.

The next challenge will be the development of methods to economically provide visibility of maintenance costs below the depot level regardless of the method of financing such costs and identified to the weapon system supported.

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The Analytical Maintenance Program: No More "Maintenance As Usual"

During AMP's earliest phase, the Navy learned how to adapt the commercial version of MSG-2 to Navy aircraft and operating environments; now some very promising results are materializing.

In 1972 the Naval Air Systems Command initiated the Analytical Maintenance Program to improve its capability to define, justify, and execute the most efficient maintenance programs possible for sophisticated aircraft weapon systems. NAVAIR realized, as had the airline industry a few years earlier, that the cost of "maintenance as usual" on new as well as planned aircraft was prohibitive. The airline industry's and NAVAIR's solution to this problem was to reconsider the fundamental reasons for performing maintenance on aircraft.

This reexamination led to the Department of Defense's Reliability-Centered Maintenance philosophy, which improves on previous maintenance program development procedures by putting the relationship between maintenance and safety into proper perspective. For instance, RCM acknowledges that maintenance per se can maintain levels of design reliability, but it cannot improve these levels. The philosophy also recognizes that failures can occur for which there exist no effective preventive maintenance tasks, and because the defects do not affect aircraft safety, such maintenance has no value. This selection logic leads to the acceptance of only those maintenance tasks wherein inherent design reliability can be maintained and positive impact on safety or economics can be demonstrated.

The principal benefits of the Analytical Maintenance Program include increases in maintenance program efficiency, minimization of aircraft downtime for maintenance, and completely auditable justification for maintenance program content. To successfully attain these objectives, AMP contains provisions for implementing and sustaining the following:

- A formally structured decision logic which examines the entire aircraft weapon system to determine its maintenance requirements.
- A clearly documented data package applied to the aircraft as well as each maintenance requirement to enable justification of the maintenance strategy.
- A disciplined process which ensures that justified maintenance requirements are efficiently performed by the appropriate level of maintenance (organizational, intermediate, or depot).
- A service feedback, analysis, and corrective action capability to monitor the effectiveness of the maintenance program, to investigate and solve reported equipment problems, and to capture specific resource savings.

by Rear Adm. Cyril T. Faulders, Jr., USN
Assistant Commander for Logistics/Fleet Support
Naval Air Systems Command

AMP's Evolution

AMP evolved in mid-1972 with the issuance of a contract to the Lockheed California Company to apply the MSG–2 planning document decision logic, which was first published by the Maintenance Steering Group of the Air Transport Association and the Aerospace Manufacturers Associations, to the maintenance program design for the S–3A aircraft. This was followed by another contract with Lockheed for the P–3 aircraft. The S–3A effort was to demonstrate that MSG–2 procedures could be applied to a new procurement naval aircraft; the P–3 effort was to determine if the process

could be back-fitted to an in-service naval aircraft.

To meet the objectives of the program, it was decided to establish a three-phase structure of analysis, implementation, and sustainment. The analyzing phase involves the application of the MSG–2 decision logic to the aircraft and the documentation of the resultant maintenance requirements. The implementing phase includes all efforts which package and publish the documentation for the total scheduled maintenance program for execution by the three levels of maintenance. Included in this phase is a sizable change in the depot work flow and process operation instructions. The sustaining phase involves all efforts to monitor service operations and adjust the maintenance program as necessary. This phase begins with the initial implementation of the "new" maintenance program and continues until the aircraft is removed from the inventory.

Transition to In-House

The early tasks in AMP, as in the cases of the S–3A and P–3 aircraft, were intended to determine feasibility and to enable in-house Navy engineers and technicians to learn the process. The Navy's objective was to transition as quickly as possible from dependence on contractors to reliance on in-house engineering and maintenance activities. Attainment of this goal was essential to ensure that the Reliability-Centered Maintenance philosophy was "firmly planted." If Navy people could not perform the analysis, how could they be expected to effectively sustain the resultant program?

Intensive training to expose Navy engineers, technicians, and analysts at all maintenance levels to the RCM philosophy was initiated primarily in-house by the Naval Aviation Integrated Logistic Support Center, although some limited training was contracted commercially. Orientation and indoctrination was provided for military and civilian management personnel from Chief of Naval Operations, Chief of Naval Material, NAVAIR, air-type commanders, fleet staffs, and Naval Air Rework Facilities (see Figure 1 on p. 18 for specific responsibilities).

During the early phase the Navy learned not only how to adapt the commercial version of MSG–2 to Navy aircraft and operating envi-

AMP helps to reduce aircraft downtime for maintenance at sea.

Figure 1. Responsibilities of Principal Navy Commands and Field Activities Having a Role in AMP

Chief of Naval Operations
- Provides maintenance program policy and direction

Commander, NAVAIR
- Coordinates AMP
- Exercises management controls
- Authorizes program funding

Atlantic and Pacific Representatives, NAVAIR
- Monitor workload and expenditures at each assigned Naval Air Rework Facility
- Conduct periodic reviews of technical progress at each assigned Navy depot

Naval Air Rework Facilities
- Perform initial analysis phase on assigned aircraft and equipment
- Coordinate analysis and requirements with alternate Cognizant Field Activities
- Review maintenance requirements based upon analysis
- Update and publish revised scheduled maintenance requirements to all maintenance levels
- Execute depot-level maintenance requirements on assigned aircraft and equipment
- Perform sustaining-phase actions to monitor and update program as required

Fleet Maintenance Activities
- Execute organizational- and intermediate-level maintenance requirements
- Provide feedback data via the 3M Maintenance Data Collection System
- Identify in-service equipment and logistic problems

Naval Aviation Integrated Logistic Support Center
- Provide engineering and technical services with respect to:
  - -- MSG-2 analysis process
  - -- 3M maintenance data analysis and computer application programs and network
  - -- Initial MSG-2 training
  - -- Technical content and update of NA-00-25-400 program manual

ronments, but also of the differences that exist when applying the decision logic to a new aircraft versus an in-service one. In the new aircraft case, a number of potentially expensive scheduled maintenance requirements can be avoided by properly designing the hardware. For in-service aircraft this is not as readily accomplished, and sometimes the only alternative is to spend scheduled maintenance resources because of the scarcity of funds for design modification.

The Navy version of MSG–2 for in-service aircraft, which reflects both early experience in the program and the inputs of in-house engineering people, has been published as NAVAIR Management Manual NA–00–25–400. In new procurement areas such as the F–18 aircraft program, whose incorporation of the RCM philosophy should result in a cost-effective and well-justified maintenance program for that system, requirements for MSG–2 decision logic have been published in Aeronautical Specification 4310.

Some Results Available

The scope of AMP coverage today is quite extensive. The objective is to have all front-line aircraft operating under redefined maintenance programs by fiscal year 1980. Specific aircraft program milestones are shown in Figure 2.

Generally, the results to date are favorable. Navy aircraft maintenance requirements are becoming more accurate, more definitive, and traceable back to documented analysis decisions and facts. Navy engineers and technicians have greatly improved their technical knowledge of naval aircraft after completing the in-depth engineering analysis. An increased awareness of both positive and negative cost implications of maintenance requirements and program decisions exists at all levels. However, while the forecast for the future is encouraging, long-term life cycle effects are unknown at this time, and better indicators of such results are anxiously awaited.

Specific program performance results and cost avoidances which have resulted from AMP are available on a limited basis at this time. The P–3 is the first Navy aircraft for which there is sufficient service experience to show actual program results (see Figures 3 and 4). For the P–3, the depot rework interval has been changed from 36 months to 60 months for each new aircraft. Depot processing at the Naval Air Rework Facility at Alameda, California, has produced a cost-avoidance savings of 2,000 man-hours per P–3 aircraft, or approximately $3.41 million in FY 1976. Further,

elimination of the requirement for functional check flights after phase inspections on the P–3 is producing savings of about $28,300 per maintenance cycle. Of course, program results will doubtless vary for each type of aircraft as more service experience is acquired with additional aircraft types.

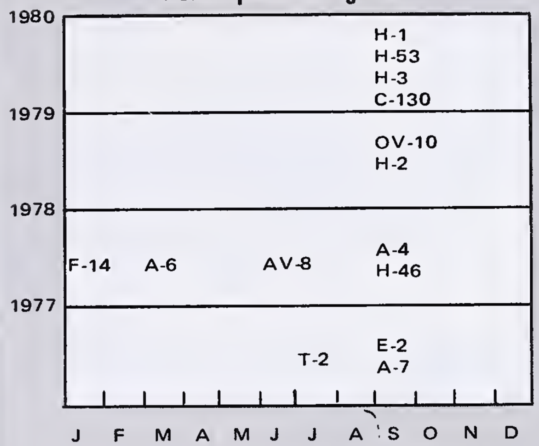
A recently completed F–4 aircraft program analysis has encouraged a number of revisions to that maintenance program: the depot rework interval is being extended from 30 to 36 months; the phase check interval is being changed from 60 to 80 hours; the maintenance cycle is being boosted from 360 to 480 hours; and there will be a net elimination of 13 scheduled component removals. These revised maintenance requirements are now being implemented Navy-wide for this aircraft.

Lessons Learned

The Navy has learned a number of lessons in executing the Analytical Maintenance Program. Among them:

- Don't become too dependent on contractors to apply Reliability-Centered Maintenance to your equipment. If your people don't understand and support it, they can't sustain it.
- If you use contractors, use those who are in the aircraft maintenance business rather than "software" houses with no real experience in aircraft operations and maintenance.
- Concentrate training in the RCM process on the working-level engineer and managers if you want the philosophy to take hold permanently.
- Educate all levels of your organization as to your objectives.
- Be careful not to "reinvent the wheel." Much of what you are now doing will probably fit within the RCM philosophy; all you have to do is modify and integrate it.
- RCM is really "new" in that it requires a fundamental change in the way we have historically perceived the concept of maintenance. For example, the concept of condition monitoring (fly-to-failure) is a basic change in traditional practice.
- Make sure you have a system to trap benefits which result from the program. This will allow for more precision and control over the budget building process and for the redistribution of resources within existing budgets.

Figure 2. Navy Aircraft Program Milestones For Implementing AMP



Note: P-3, S-3, and F-4 aircraft are currently operating under AMP.

Figure 3. Changes in P-3 Aircraft Depot Maintenance Tasks Under AMP

Original depot specification tasks	900
Tasks shifted to organizational maintenance	-501
Recurring tasks eliminated	-112
One-time, nonrecurring tasks eliminated	- 30
Added tasks due to restructuring	+190
Added tasks based on Navy review	+ 17
Current depot specification tasks	464

Figure 4. Changes in P-3 Aircraft Organizational Maintenance Tasks

	Tasks Before AMP	Tasks After AMP	Net Change
Preflight/Postflight	224	106	-118
Daily	151	48	-103
Periodic	795	434	-361
Special	151	96	- 55
Total	1,321	684*	-637

**Of these, 269 have a decreased inspection frequency, while 22 have an increased inspection frequency.*

The S-3A aircraft incorporated MSG-2 decision logic in its maintenance program design.

AMP is being revised based on an analysis of the F-4 aircraft program.

MSG-2 procedures were back-fitted to the in-service P-3 aircraft.

• Don't assume that RCM will automatically reduce the amount of money you spend on the scheduled maintenance program. Let the hardware dictate scheduled maintenance via the decision logic.

• Emphasize analysis process discipline and accountability. Don't be excessively rigid and stifle creativity on the part of your engineers and technicians, but remember the pressure is always there to fall back into the "business as usual" syndrome.

• You must invest money to get the job done (AMP is currently programmed at an average of \$7.5 million per fiscal year through FY 1983). The complete rethinking of the in-service maintenance plans for major aircraft weapon systems is no small task and hence requires adequate funding. DMJ

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Admiral Faulders is a graduate of the U.S. Naval Academy and the Naval School of Electronics at the Massachusetts Institute of Technology. He holds an M.A. degree from Stanford University.

C-9 Case Study

A Contractor's View of System Support

In a number of instances, rising support costs can best be controlled by using contractor system support in lieu of organic support.

A review of cost drivers indicates that often the management of support for a system can affect costs as positively as the development of unreliable or unmaintainable systems affects them negatively . . . Proportionately more attention (in the acquisition process) is being focused on the logistic attributes of a system . . . More questions are being asked concerning the comparisons of logistics alternatives. . . .

Colonel Elbridge P. Eaton, Jr., USAF
Defense Management Journal, *January 1977*

by Harold Bayer
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Opinions expressed herein are those of the author and not necessarily those of the Department of Defense.

One is tempted to ask, "Is it economically feasible to control rising support costs by 'going outside' for system support?" The answer is an unequivocal yes! In fact, contractor support has been around in varying degrees for many years. Custer, at least at times, used the local smithy to repair the shoes on his horse. And I suspect Washington's crossing of the Delaware was done in a non-mil-spec boat maintained by commercial sources. But only in recent years has contractor support come into formal status.

The defense establishment has responded admirably to the budgetary and inflationary pressures which continually threaten our capability as a nation to select, develop, produce, and operate the multitude of sophisticated systems and subsystems necessary to support the defense posture upon which most of the free world is dependent.

As this response has resulted in, and continues to stimulate, a veritable explosion of innovations in defense management science, Douglas has worked over the past decade with the Air Force—and later the Navy and Marine Corps—in a program which uniquely typifies the opportunities to combat the budget crunch through two important techniques: off-the-shelf procurement and contractor system support. Since off-the-shelf procurement has been widely treated in the literature, this article will address the concept of contractor system support. It is a concept that has proven so effective in the C–9 transport system that I wish we could claim credit for the idea. But it didn't happen that way.

Aeromedical Airlift Mission

The operational requirement for the CX–2 transport (later designated C–9) stemmed from the domestic aeromedical airlift transport task performed by the 375th Aeromedical Airlift Wing of the Military Airlift Command. In the mid-1960's the 375th had the job of transporting 40,000 Department of De-

fense patients annually over a route system that used more than 500 airports and included some 600 medical facilities and 50 major treatment centers. Its fleet was flying 6 million route miles, there was a continuing increase in demands for continental U.S. service, and the requirement for moving ill and injured patients arriving from overseas commands was heavy as well as urgent. The wing had a fleet of 15-year-old prop-driven aircraft which were inadequately equipped, required unnecessarily long hours on trips, and frequently had to stop overnight en route to treatment centers, because of the slower-speed, propeller-type aircraft and the fact that some fields shut down for night operations.

Three contractors responded to the request for proposals to modernize this force. The Douglas proposal involved extensive interior customizing and modification of a DC–9 twin-jet transport design, already ordered in four basic versions by some three dozen of the world's airlines. Besides accommodating varying combinations of litter and ambulatory patients, it would provide special integral ramps for loading litter patients, a sealed special-care compartment for isolating and caring for special cases, stations for nurses and aeromedical technicians, galleys, and other peculiar medical equipment. In addition, it would replace the existing fleet by a better than one-to-two ratio, provide jet comfort, and virtually eliminate overnight stops with patients.

Our engineering teams had been working with the Military Airlift Command and the Air Force aeromedical people for several years on the transport concepts. We were quite confident that the modernization would justify itself on cost-effectiveness as well as humanitarian grounds. Then came the surprise. It was just less than 6 months before contractor selection, and Douglas executives were briefing a senior delegation from Air Force Headquarters. We had talked about the company, its industrial base, the DC–9 program, and the technical aspects of the proposed transport. Then we began outlining the logistics support program on a conventional organic basis. We were listing the levels and costs of required supplies when the late Lieutenant General T. P. Gerrity, then Deputy Chief of Staff, Systems and Logistics, quietly interrupted. "No," he said. "You buy the supplies. You support it."

Comparative Analysis

We responded affirmatively and quickly saw the potential savings and efficiency benefits of contractor support. But the concept was relatively new in the Air Force, and much discussion and planning had to take place before it could be adopted. In the meantime, competing contractors were required to prepare parallel proposals, one with organic support and one with contractor support. It was not until the selection of McDonnell Douglas to produce the C–9A (production designation) was announced on August 31, 1967, that the decision in favor of contractor support became final.

During the 6 months prior to contractor selection, our analysis of the comparative support systems made interesting inputs for our proposal. Most notable were the following:

- The Air Force could effect an immediate savings of about $7 million in initial spares which would have to be stockpiled by the contractor, or more than 20 percent of the estimated cost of organic support for 5 years.
- Over a 5-year period, just recurring costs of organic support would be at least 50 percent higher than contract support costs.
- Total costs of organic support over 5 years would be nearly double the cost of contractor support, as later verified by a separate cost study made by the Air Force Logistics Command (see Figure 1 on p. 24).

After we won the contract, it was up to us and the Air Force to prove we were right. We had a year to organize the support system, arrange for the manpower, acquire initial spares including long-lead-time items, modify DC–9 commercial manuals to adhere to military specifications, and get the necessary training under way.

Procurement of the C–9A aircraft and peculiar aircraft ground equipment was the responsibility of the Air Force Systems Command, but logistics support was the bailiwick of the Air Force Logistics Command. Systems management was placed in the hands of San Antonio Air Materiel Area, now known as San Antonio Air Logistics Center. The support contract is administered by the SA–ALC; this includes payment for services rendered, monitoring of incentive or penalty clause performance, and negotiation of contracts with 1-year options for renewal solely at the discretion of the Air Force.

Basically, the C–9 support

concept calls for coordinated teamwork between the Air Force and McDonnell Douglas. The Air Force retains systems management and performs flight-line, on-aircraft maintenance. McDonnell Douglas performs or subcontracts all off-aircraft maintenance, including heavy checks, component repair, and engine overhaul. The contractor also provides all logistics support, including all spare parts.

Of course we don't do the whole job ourselves. We depend on a subcontract plan which gives us the flexibility to subcontract work, such as heavy maintenance checks, to those available and authorized commercial sources which offer superior quality work and rapid turn-around times, thereby further utilizing the private sector as encouraged by government policy.

The spares inventories (including engines) and peculiar support equipment spares are furnished, kept up to date, repaired, and replenished by McDonnell Douglas. And that rather sizeable inventory is owned entirely by the contractor.

Organizational and some limited intermediate-level maintenance are performed by using commands on a remove-and-replace basis, with the contractor responsible for having the replacement parts ready to go on the aircraft. Our organizational mechanism for meeting these responsibilities was designated Contractor Operated and Managed Base Supply, which is managed through the Douglas/SA–ALC interface.

The COMBS facility at Scott Air Force Base, Illinois, home of Military Airlift Command and home base for the 375th Aeromedical Airlift Wing, was set up with a base manager and secretary, seven supply representatives, and five highly trained field service representatives—two each for aircraft general and avionics and one for engine field service (the number of representatives was reduced to three after the first 24 months). COMBS is responsible for all levels of spares support, with 24-hour service 7 days a week. It maintains computerized inventory records of all stocked common or peculiar spares, and

Figure 1. C-9A Support Concept Estimated Cost Comparison[1]

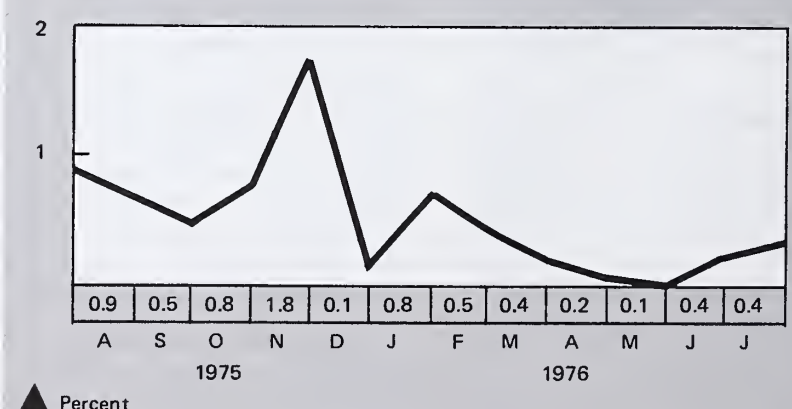
	DAC[2] Contract	AFLC[3] Contract	AFLC[3] Organic
Investment Cost			
Spares	--	--	7.680
Initial AGE/Spares	0.371	0.173	--
On-board Spare Kits	0.432	0.432	--
Aircraft Heavy Maintenance	2.356	2.050	2.050
Contract/Air Force Management			
Administration and Incentives	1.860	1.973	.184
Technical Representatives	1.033	0.280	0.127
Recurring			
Supply and Maintenance	7.138	9.167	20.453
Manpower	1.845	4.696	4.696
Total 5-Year Program Cost	15.035	18.771	35.190

[1] 1967 escalated dollars (millions) for first 5 years of operation.

[2] Douglas CX-2 proposal, Report 3478-6-CE, June 14, 1967.

[3] Air Force Logistics Command, C-9A Cost Study, April 30, 1969.

Figure 2. C-9A Domestic Not Operationally Ready Supply Rates*



NORS baseline = 5 percent.

subcontracts airframe component and engine repair and overhaul to Federal Aviation Administration-licensed repair stations. COMBS is prepared to provide most high-usage spares within 30 minutes, and non-inventory spares within 24 hours of requisition.

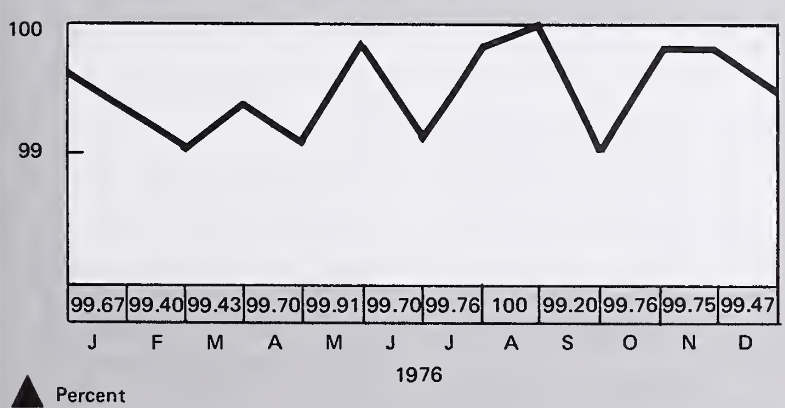
The operational unit needs no training on parts repair, stock catalogs, or supply record keeping. It simply provides scheduled inspections and remove-and-replace capability. Here the contractor's expert field representatives come in most handy, providing on-the-job instruction in maintenance, technical assistance in functional checkouts, and help in troubleshooting to avoid unnecessary equipment removals. They also advise the unit on the use of peculiar ground support equipment, and provide data feedback for design and reliability analyses. They are always there or available, and the Aeromedical Airlift mission is programmed so that all jet aircraft can perform their assignments and return to home base at night, with rare exceptions.

An on-board spare parts kit is available for use by the single maintenance man on the flight crew, whose normal duties are supervising en-route service during missions. In the event that a part is required in the field and is not available in the on-board kit, the COMBS manager probably can quickly find one in the closest COMBS or in Douglas's inventory at Long Beach. If all else fails, the manager will find a commercial DC–9 operator who can make the part available.

The Bottom Line

As noted earlier, comparative estimates done by the SA–ALC Systems Management Office in 1969 predicted that C–9 contractor support should cost the government about $18.8 million as compared to C–9 organic support of $35.2 million, or a 46 percent savings over a 5-year period. Unfortunately, predicted savings are difficult to validate at best because there are no historical data for the organic support case. The C–9 has never been supported organically by the Air Force. However, the contractor support case can be substantiated by looking at actuals compared to earlier estimates. A government auditor's report published in January 1974 examined the cost estimates contained in the 1969 SA-ALC study. Of the seven contract line items examined, which incidentally accounted for 87 percent of total cost, the auditors found such a small variation (e.g., 3.9 percent of recurring costs) that they concluded, "the initial C–9A Cost Study is considered a realistic cost estimate for those costs estimates."

Figure 3. C-9A Domestic Home Station Mechanical Departure Reliability Rates



Readiness and Reliability

The C–9 started flying from Scott Field in August 1968 (just 12 months after go-ahead for contractor support). Results of combining the off-the-shelf DC–9 with a contractor support concept became apparent almost immediately. The C–9A became—and remains—the most reliable and cost-effective air transport system in Air Force history. Operational readiness rates, with a standard of 80 percent, went immediately above 90 percent and have generally remained well above that figure. Not Operationally Ready Maintenance rates, with a standard of 15 percent, generally have averaged about 10.5 percent for the first 5 years. Not Operationally Ready Supply rates dropped immediately to zero and have remained generally below 1 percent, against an Air Force standard of 5 percent (see Figure 2).

But the biggest item in terms of getting the job done is the mechanical departure reliability rates (see Figure 3). Against an Air Force standard of 95 percent, which historically has been

The C-9 support concept calls for coordinated teamwork between the Air Force and the contractor.

difficult to achieve, the C–9A fleet remained above 99 percent during the first year's operation and has remained between 99 and 100 percent for nearly a decade. (What's so special about a 99 percent departure reliability rate? One must remember that the critical burn patient needs prompt, dependable transport.)

All of that adds up to superior system performance, with support at half or less of the cost for organic support. And this performance has been verified by Military Airlift Command operational test and evaluation and in more detail by the AFLC cost study and option decision evaluation reports. The success resulted in expansion of COMBS to additional theater aeromedical fleets with bases at Clark AB, Philippines, and Rhein-Main AB, Germany; to similar facilities (with minor changes to accommodate different missions) to support Navy C–9B transport operations at the Naval Air Station in Alameda, California, and NAS Norfolk, Virginia; to the VC–9C Special Air Missions operation at Andrews AFB, Maryland; and to the C–9B operation at the Marine Corps Air Station at Cherry Point, North Carolina.

Much of the credit for this success must go to the organizations and people involved, as well as the businesslike manner in which the Air Force went about launching, testing, auditing, and managing the system. For example, Military Airlift Command set up special units and channels of communication to spot existing and pending problems quickly and to get corrective action under way without delay. San Antonio Air Logistics Center managed the contracts with encouragement rather than obfuscation, and maintained clear, detailed, accessible, and up-to-date data on support operations.

The C–9 system has indeed made a case for contractor support of items which have been procured in essentially an off-the-shelf configuration. Already a similar system has been applied to the T–43 navigator training aircraft, and has been described by the USAF Headquarters Procurement Management Review team as "extremely successful." The contractor support concept also fits quite nicely, with considerable savings to DoD, with the government's general policy of relying on the private enterprise system to supply its needs, as outlined in the Office of Management and Budget Circular A–76 and furthered by a recent Presidential Management Initiative (dated July 1976).

But before we get completely carried away and declare the contractor support system a panacea, it behooves us to consider the unique or unusual aspects of the C–9 program which made it an ideal vehicle for pioneering the concept.

The C–9 was based on a commercial transport airframe and

C-9A modifications to the DC-9 included an integral ramp for loading stretcher patients.

systems—except for those peculiar to the C–9 mission—already in production, already widely in use in the U.S. and abroad, and with an international commercial support system already working within the stringent demands of commercial airline scheduling. With then almost 300, and now well over 800, DC–9's in commercial service, the supply system base was operational and growing rapidly. The DC–9 had established and has since maintained a reliability record unmatched by other twin-jet fleets. It was not necessary to alter the commercial support system to incorporate COMBS operations, and the only times system procedures had to be altered were the same times they would have been altered for commercial support to get an aircraft back into the air quicker.

Furthermore, the C–9 is a nonvital system in that its operation has little immediate impact on the tactical or strategic readiness of DoD's combat arms. Under the C–9 support contract, the government has the option to terminate by buying out the contractor's assets, or to provide additional funding necessary for relocating support facilities in the event of contingencies.

Decision Criteria

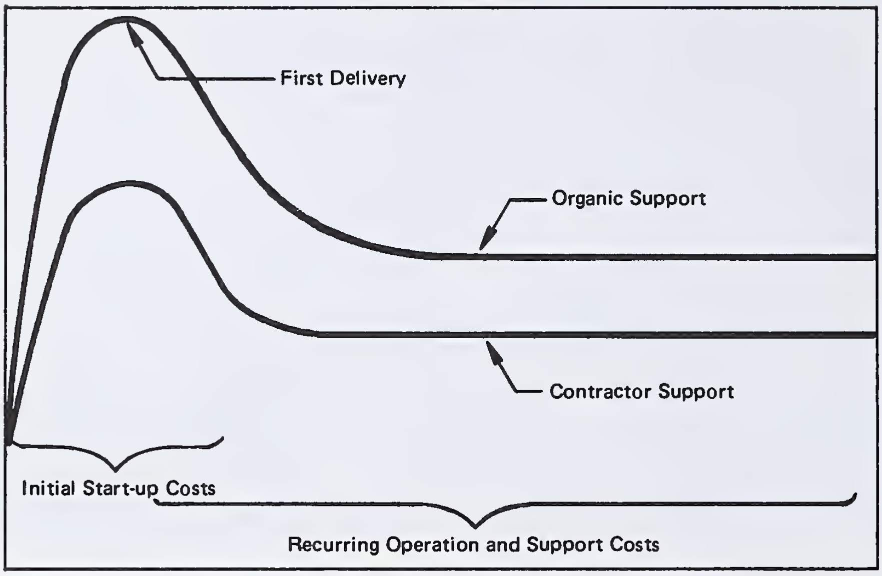
Some criteria occur to the contractor, and no doubt more occur to professional defense systems managers, which must be fully considered before contractor support can be recommended for a specific system:

- Does the system have sufficient similarity to a commercial product to make existing support readily adaptable?
- Is the commercial product performing satisfactorily?
- Is the commercial product outlook sufficiently bright to indicate the long-term production necessary to ensure continued adequate support?
- Would contractor-labor relationships affect the program?
- Can requirements for the force size or utilization under consideration be met within the capacity of the commercial support system?
- Are the adaptations necessary for the commercial support system to provide adequate service considered reasonable?
- Is security a problem?
- Does the commercial support infrastructure have sufficient elasticity to accommodate surge or contingency?
- Is the support system viable or replaceable in the event of war?

Undoubtedly there are defense systems which, for reasons implied above or because of other criteria, would not be acceptable candidates for the contractor support concept. But just as surely, there will be similar efforts to come which can effectively take advantage of the C–9 experience.

One of the latter which comes to mind immediately is the Air Force's proposed Advanced

Figure 4. Cost Relationship of Contractor Support vs. Organic Support as a Function of the Life Cycle for the Advanced Tanker/Cargo Aircraft Program



Tanker/Cargo Aircraft (see Figure 4). This system would be based on an existing wide-cabin jet transport, modified to accomplish the required missions but maintaining airframe and system commonality with the commercial infrastructure. Our estimates indicate that life cycle support cost savings of 30 to 40 percent would be possible through contractor support of such a system. And the system would be similar to a commercial product already performing satisfactorily, with long-term production virtually assured, with worldwide support systems already in place and operating, and with integration of military system support already proven to be simple and effective.

But the Advanced Tanker notwithstanding, real benefits to the taxpayer in the form of reduced operation and support costs are possible, provided the support concept fits the criteria of commercial derivatives and established support systems. Substantial benefits also accrue to the military user in the form of greater reliability and increased readiness.

Based on nearly a decade of C–9 system performance, there is no doubt that the projected savings and efficiencies make it well worth analyzing any system which might be a candidate for contractor system support. In the case of the C–9, the contractor is happy making a profit, the Air Force is happy with a support concept which has exceptional response, and the taxpayer is saving a lot of money. DMJ

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Mr. Bayer joined Douglas more than 38 years ago and, except for a 2-year period, his career has been devoted to developing methods for safe, cost-effective aircraft support. He has had experience in all phases of product support including publication of manuals, training, field service, spares, and support equipment.

Interim Contractor Support as a Prelude to Organic Maintenance

Interim contractor support is not new, either in theory or in practice, but its redefinition and use as a planned support option are new.

The increasing complexity and cost of acquisition and modification programs within the Air Force mandate a continuous review, throughout a system life cycle, of all aspects of logistic support. We can no longer routinely delay or postpone decisions affecting this support during the conceptual, validation, or full-scale engineering development phases with the idea that for a few extra dollars, the necessary support will somehow materialize when the system or equipment becomes operational. The Air Force's frequent failure to invest research and development dollars to reduce future operations and maintenance costs is nothing less than short-sighted and shifts funding problems downstream.

This situation is incompatible with current DoD direction. With the increasing emphasis on total life cycle cost management, accurate projections of support requirements and a definite commitment to their attainment early in the program are essential. As a result there is a new Air Force approach to making the transition from a contractor-supported system to an organically supported system with a minimum of cost and schedule impact. Air Force implementation of this approach is via Air Force Regulation 800–21, "Interim Contractor Support for Systems and Equipment," dated September 26, 1975.

by Maj. Robert A. Gulbrandsen, USAF
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Organic Support Emphasized

Until recently, Air Force program managers planned for an organic maintenance capability concurrent with delivery of the first article of equipment to an operational unit. The extent of maintenance support was considered on a case-by-case basis for each equipment type, but always under the assumption that the Air Force would be capable of providing immediate and complete organic maintenance support. Insufficient consideration was given to an item's design status (stable versus unstable) and the effect of this status on organic support.

The investment in equipment, facilities, or trained personnel already made by the contractor was not regarded in early planning as a resource which could be utilized until organic support could be most cost-effectively phased in. Thus, to overcome support deficiencies in a last minute crisis, sole source negotiation usually took place to have the contractor perform some or all of the early logistic support. As neither the Air Force nor the contractor may have planned for this possibility,

excessively high costs, disruptions to production schedules, and delayed field support often resulted.

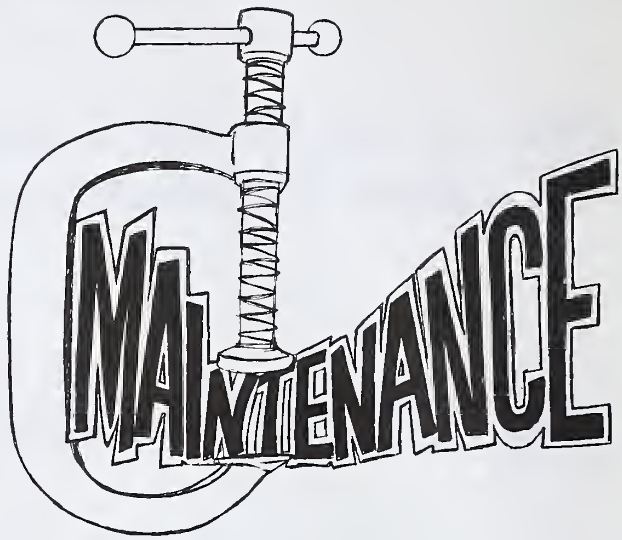
In the late 1960's, studies were undertaken by the Department of Defense and various private agencies to determine an optimum mix of government-contractor support on newly acquired systems. This was in sharp contrast to the more or less automatic decision that organic support should occur when the first end item became operational, or as soon thereafter as possible. The studies soon indicated a need for a more exhaustive data base of experience from previous programs as well as more accurate projections on new programs.

Fly Before Buy

One of the first concerted efforts to integrate all of the support information gathered and use it for decision making was the establishment of the fly-before-buy concept. This essentially separated development and production into two distinct phases, the production decision being made only after the equipment had been thoroughly tested and proven. One unexpected benefit of this concept was the corresponding slip in required support dates because of the later production decision. It permitted a catch-up in delivery of long-lead support items during the extended development phase and allowed some breathing space during and after validation to ensure that the necessary support resources would be provided concurrent with their need.

Maintenance continues to be the primary pacing function of systems support, while other support elements, including spares, technical data, support equipment, repair parts, tools, personnel, and facilities, are integral elements of the maintenance planning for that system and compete for the limited funds available. In this context, resource limitations should not be thought of merely in dollars (although dollars are a limiting factor), but also in terms of other resources.

In industry, the lack of a piece of equipment when it is needed is expressed in dollars due to lost productivity, but in the military it could mean the difference between victory or defeat. Viewed from that perspective, the cost of not having an item can far outweigh the cost of having too many.



In the search for ways to reduce maintenance costs, serious study has been made by the Air Force of reducing either the level or the frequency of maintenance; however, since a reduction in maintenance quality could seriously degrade operational effectiveness, the consequences must be carefully considered. The most promising long-term solution is to reduce the need for maintenance. While it is unlikely that maintenance can be totally eliminated, it can be significantly reduced if every effort is made in the development of new and modified equipment to ensure that reliability and maintainability are considered as principal design parameters.

Interim Contractor Support

An alternative to the immediate implementation of organic support, which is being utilized more and more in an effort to decrease overall logistic costs, is planning for and making better use of interim contractor support. While ICS is not new, either in theory or in practice, its redefinition and use as a planned support option are new. Previous policy emphasized limited use of contractor support, until organic capability goals could be met, under such terms as phased logistic support or initial support.

This policy was reexamined by both Air Force and DoD study groups in the early

1970's. The studies reconfirmed the Air Force's belief that unrealistic initial operational capability schedules and the associated organic logistic support dates often resulted in costly decisions to prematurely acquire support equipment, spares, and technical data. A good example was the F/FB–111 aircraft procurement in which the specified sophistication in hardware and automatic test equipment was just barely within the state-of-the-art and required costly and repeated modifications to hardware, spares, and test equipment and rewrites of technical data after it was fielded.

Though the studies also reaffirmed the principle of organic support for mission-essential systems, more importantly, they emphasized the point that the operational date of an organic maintenance capability must be determined primarily by the design stability of individual components and subsystems.

In 1972, a joint DoD-industry integrated logistic support advisory committee was formed to address significant logistics problems which included development of a concept for phased logistic support which projected initial utilization of the contractor's excess production capacity in place of organic maintenance, gradually phasing it out as full production and organic support were achieved. The committee recommended that cost-effectiveness and design stability be given as much emphasis as operational requirements in the decision to use contractor in-house initial support. The work of this committee helped to further the evolving Air Force policy for ICS.

DoD Directive 4140.40, "Basic Objectives and Policies on Provision of End Items of Material," published February 20, 1973, further helped to clarify the considered use of ICS. This directive mandated that the integrated logistic support plan provide for the most cost-effective logistic support posture. In designating items for contractor support consideration in the early deployment period, it identified those with poor reliability, unstable design, or high risk and high unit cost as the most likely candidates.

Policy Revised

In light of this directive, the Air Force attempted to determine both the situations where use of ICS would be appropriate and the conditions which would make it less attractive. A comprehensive analysis of previous study results, DoD policies, and the practices of other services, as well as Air Force experience with the use of contractor support, resulted in a reappraisal of Air Force policies. These policies were embodied in Air Force Regulation 800–21, which defines ICS, provides guidance in the timing of decisions, and assigns various Air Force organizations specific responsibilities in the ICS decision and application process. Essentially, this directive requires that the ICS option now be evaluated early to include it in competitive source selection, and that it be utilized when it is determined to be the best alternative for a specific period of time prior to achieving full organic capability. Implicit in the directive is the intent to anticipate, early in the acquisition cycle, those items susceptible to design problems. The items highlighted can then be given increased management attention in an effort to resolve these problems and planning can take place to make best use of available resources and phase in organic support when it is cost-effective to do so.

Delays in attempting to use this concept have resulted in:

- Program turbulence during initial deployment with high NORS (not operationally ready supply) rates until ICS procedures were fully implemented, as in the F–111 example.
- Lack of excess production capability to take care of reparables and a bill for additional production test equipment, as experienced in smaller programs which have achieved early full production rates.

The increasing complexity of weapon systems, sustained operational readiness requirements, life cycle cost considerations, and budget constraints demand the prompt and efficient evaluation of each support alternative.

In recent acquisitions, there has been a trend toward the use of ICS which has proven advantageous for the following reasons:

- It permits an accumulation of usage data prior to the organic capability date, thus providing more accurate information for the provisioning process and the establishment of organic support levels.
- By allowing the design to become more stable prior to provisioning, it delays the provisioning decision to a more logical and cost-effective point in time.

• During the initial period of ICS use, there is more excess production test equipment available and perhaps a higher ratio of spares to like installed items, as well as potential for more rapid and economical response to design changes by the contractor than could be attained through organic support.

• There is more time available to develop field and depot support equipment and technical data.

Contractor Motivation

The primary reason for these advantages is that, if ICS is properly negotiated early in a competitive environment, the contractor normally uses every means available to respond to changes required in the support of his delivered equipment. If he must maintain the equipment for an extended period of time at a fixed total price, there is a strong monetary incentive to achieve economies in support operations. When an unexpected problem occurs during the ICS period, the contractor is motivated to correct the cause rather than the effect so as to reduce the number of future repair actions over the remainder of the support period. Corrections of such problems also tend to be quicker and more efficient because of the contractor's continued total involvement with the system and greater in-depth knowledge of the equipment.

For these reasons the Air Force is carefully planning the implementation of ICS on selected avionics subsystems of the B-1 and F-16 aircraft and will include it in competitive source selection for use on the advanced medium STOL transport.

At the same time, there are drawbacks to the use of ICS. The principal one is that if it is done improperly, we again fall back into a sole source renegotiation and extended contract support which may be more expensive than organic support. This cost difference almost always increases over a period of time, so that at some point, the economic necessity of changing to organic support overrides all other considerations.

Sometimes, too, the pressures of inflation and approaching operational dates cause program managers to request use of ICS to delay funding of organic support requirements. This is misuse of ICS and should be avoided.

ICS can also be risky because of the contractor's susceptibility to work disruptions, such as strikes, which are not encountered when using organic support. An additional disadvantage is that there is another layer of contracting and administrative management between the resources and the user.

The decision as to when to establish organic maintenance for a system and discontinue the use of contractor support will significantly impact the cost of this support. It should be based on a careful assessment of system performance, subsystem and support equipment stability, and technical data availability; in short, total system supportability. It must be remembered, however, that there are certain pitfalls to this type of decision process: the situation is dynamic, the assessment must be continuously iterated to ensure timeliness, and there will seldom be an absolute superiority of one type of support over another.

Conclusion

Given these arguments, the logical conclusion is that there is a continuing requirement for an equipment maintenance program utilizing both organic and contractor support of Air Force systems. Acceptance of the ICS concept, early planning to include it in competitive source selection, and effective management of its application will ensure its success.

Ultimately, however, only a careful balance of both types of support will achieve the cost-effective and responsive support posture required for the successful completion of each weapon's assigned mission. DMJ

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He holds a B.S. degree from the University of Nebraska and an M.S. degree from the Air Force Institute of Technology. Major Gulbrandsen also graduated from the Industrial College of the Armed Forces, the Command and General Staff College, the Squadron Officer School and the Communications-Electronics Staff Officer Course.

"Going Commercial" with the Commercial Commodity Acquisition Program

The Commercial Commodity Acquisition Program is a new Department of Defense initiative to increase significantly the percentage of DoD materiel requirements which are satisfied from the commercial marketplace. By buying off-the-shelf products, DoD avoids costly and time-consuming research and development, and in the process lowers unit production costs. Equally important is the potential for cost avoidance through the use of commercial logistics support. In this article, the author delves into CCAP's pilot program, a "learn by doing" effort involving the acquisition of some forty different products. He analyzes the program in detail with respect to its policy-developing and support considerations as well as its comprehensive impact on the conduct of business in the defense community. Such problems as overspecification of requirements and lack of control over design criteria are weighed against such potential payoffs to both DoD and industry as lower costs, a shorter acquisition cycle, increases in competition, and improvements in the defense industrial base. The argument for "going commercial" is quite persuasive.

The Department of Defense is "going commercial." Depending on the audience, such a statement evokes responses ranging from outrage to benign acceptance to "so what else is new?" And when it is pointed out that going commercial means not only procurement of commercial products, but also procurement of long-term commercial logistics support, certain elements really lose their balance.

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There are two basic reasons for such a response: the Commercial Commodity Acquisition Program is going to change the way DoD traditionally does business, which challenges Newton's first law of motion—"bodies at rest tend to remain at rest"; and people erroneously conclude that CCAP is synonymous with the rampant proliferation of poor quality, unsupportable commercial products in the military user environment. Brought about by past experience, this misconception basically portrays what CCAP is not!

CCAP is a DoD initiative to significantly increase the percentage of DoD requirements for equipment and materials which are satisfied from the commercial marketplace. Complementing this objective is the desire that private-sector or contractor logistics support be utilized where such an alternative proves feasible and cost-effective.

Many of the horror stories which tell of the proliferation of unsupportable commercial equipment during the Viet Nam conflict are true. However, one must understand that our armed forces would have been in serious trouble had not the commercial marketplace been able to respond to requirements on short notice. These commercial products filled a critical gap

which existed because of the long lead times associated with military procurements and the establishment of organic logistics support capability.

A successful CCAP will establish viable Office of the Secretary of Defense policy and a new acquisition methodology which will provide for effective commercial acquisition and support planning. The result will be an orderly flow of supportable commercial products which meet DoD user requirements. A very clear benefit of DoD going commercial through a series of rational acquisition and support decisions will be to preclude Viet Nam-type situations in the future. The industrial base will broaden. And commercial suppliers will become attuned to military requirements and therefore will be much more capable of responding to them on a life cycle basis.

Is a Special Program Necessary?

But why institute a special program like CCAP when DoD already procures commercial "off-the-shelf" products on a very extensive basis? This fact is readily acknowledged; however, as it stands now, the DoD requirements being satisfied by commercial products are largely for consumables and the more mundane items such as transformers, soldering irons, photographic paper, and selected electronic components. CCAP will encompass all user requirements, but will focus on those which express a need for more sophisticated products such as radars, radios, and test equipment. The idea is to exert the greatest effort, in terms of planning and management, in those product areas which promise the greatest payoff in cost-of-ownership savings.

It is only necessary to examine the number of dollars spent on research, development, and procurement of electronics and avionics systems and subsystems, to say nothing of life cycle support requirements, to make one realize that DoD will soon be financially unable to field and support needed weapon systems. Steps must be taken to utilize available funds more effectively, and CCAP represents a giant step in this direction.

The number of government dollars spent for research and development has been on the decline since 1970. In that year, expenditures approximated 2 percent of the nation's Gross National Product, whereas today, expenditures represent only 1 percent of the GNP. While it is true that, in absolute terms, this percentage represents a significant number of dollars, it also represents a 50 percent relative decrease in government R&D expenditure. While there are signs that this trend may be reversing, there is little doubt that positive action must be taken to ensure that available R&D funds are utilized in the most effective manner. This can be accomplished by buying existing or off-the-shelf products when they will do the job. DoD thereby avoids costly and time-consuming R&D and frees funds to satisfy legitimate R&D requirements.

There are other distinct advantages to buying commercial. Unit production costs will be lower for two basic reasons: DoD pays only a small share of the nonrecurring costs associated with R&D; and DoD can take advantage of the lower costs accruing from high-volume production, which is frequently a characteristic of commercial products.

Support Considerations

In the support or logistics area, operation and support costs are getting totally out of hand, primarily because of the high costs of manpower resources and supply system inventories. The manpower cost in the maintenance area is due in part to high turnover rates and inefficient utilization of personnel resulting from frequent job rotation, with the job often completely unrelated to the previous job. The cost of supply system inventories and their management is being considered in the development of a total cost model as a part of the Commercial Item Support Program. Under CISP, all potentially commercial items will be reviewed to determine the minimum level of centralized management needed, with emphasis on maximum use of the commercial distribution system.

Support facilities are another problem. Because of funding shortfalls and facility closings, the Defense Department is slowly but surely losing depot support capability. The use of contractor logistics support is one means of coping with these problems. DoD has been effectively using contractor logistics support for many years to support major weapon systems all over the world. The problem has been that it is not always cost-effective, and DoD has used the concept primarily as an interim measure pending the attainment of organic support capability. Under CCAP and CISP, commercial end items will be re-

viewed in accordance with established criteria; this will require an evaluation of logistics support alternatives and provide a basis for quantitatively determining the most cost-effective alternative for support over the entire product life cycle.

As for consumables, DoD is dealing with literally millions of products, most of which are centrally procured, managed, and stored in government depots. The demand rate for a significant percentage of the centrally managed and stored items is virtually nil. Thus, millions of dollars in manpower and facilities are spent to centrally manage and store materiel which has little or no turnover. Obviously this kind of operation cannot be cost-effective.

Admittedly, some portion of this materiel must be managed in this manner in order that it be readily available for war emergencies and various contingencies; but the percentage is small in relation to the total of materiel stored in government depots. The question then arises: Why not use the commercial supply and distribution system for much of this materiel? Indeed, DoD should use it where it is cost-effective and adequate to serve defense needs. Thus, the initial thrust of CISP is in this area.

The repairable system represents a far more complex logistics problem and is primarily represented in the CCAP effort. There are the basic logistics variables such as test and support equipment, spare parts, personnel, training, publications and other technical data, facilities, and transportation and handling, all of which drive cost and readiness. In addition, reliability and maintainability, both of which are nonlogistic design variables and performance parameters, exert a significant logistics cost influence and at the same time drive readiness. When DoD buys off-the-shelf commercial products, it loses control of R&M design. Thus, DoD must ensure that its R&M requirements are met through test and evaluation and other means before the products are accepted by the government.

Obviously, the logistics support decision is critical to both the life cycle cost of a repairable system and the capability of that system to contribute to operational readiness; it must therefore be made based on valid, quantitative analyses of all the variables involved.

Where Is CCAP Going?

Initiated in January 1977, the Commercial Commodity Acquisition Program is a means to an end; as such, it will cease to exist as an identifiable program once its objectives have been met. The nucleus of CCAP is a pilot effort involving the acquisition of some 40 different products. It is a "learn by doing" program.

The military departments and the Defense Logistics Agency were requested to provide candidates for the pilot program, each representing a current user requirement for materiel. Among the wide range of products involved are:

- An ultrasonic cleaner for the Marine Corps.
- An airborne navigational receiver (Army).
- An airborne video tape recorder (Air Force).
- A navigation system (Navy).
- A white bath towel for the Defense Logistics Agency.

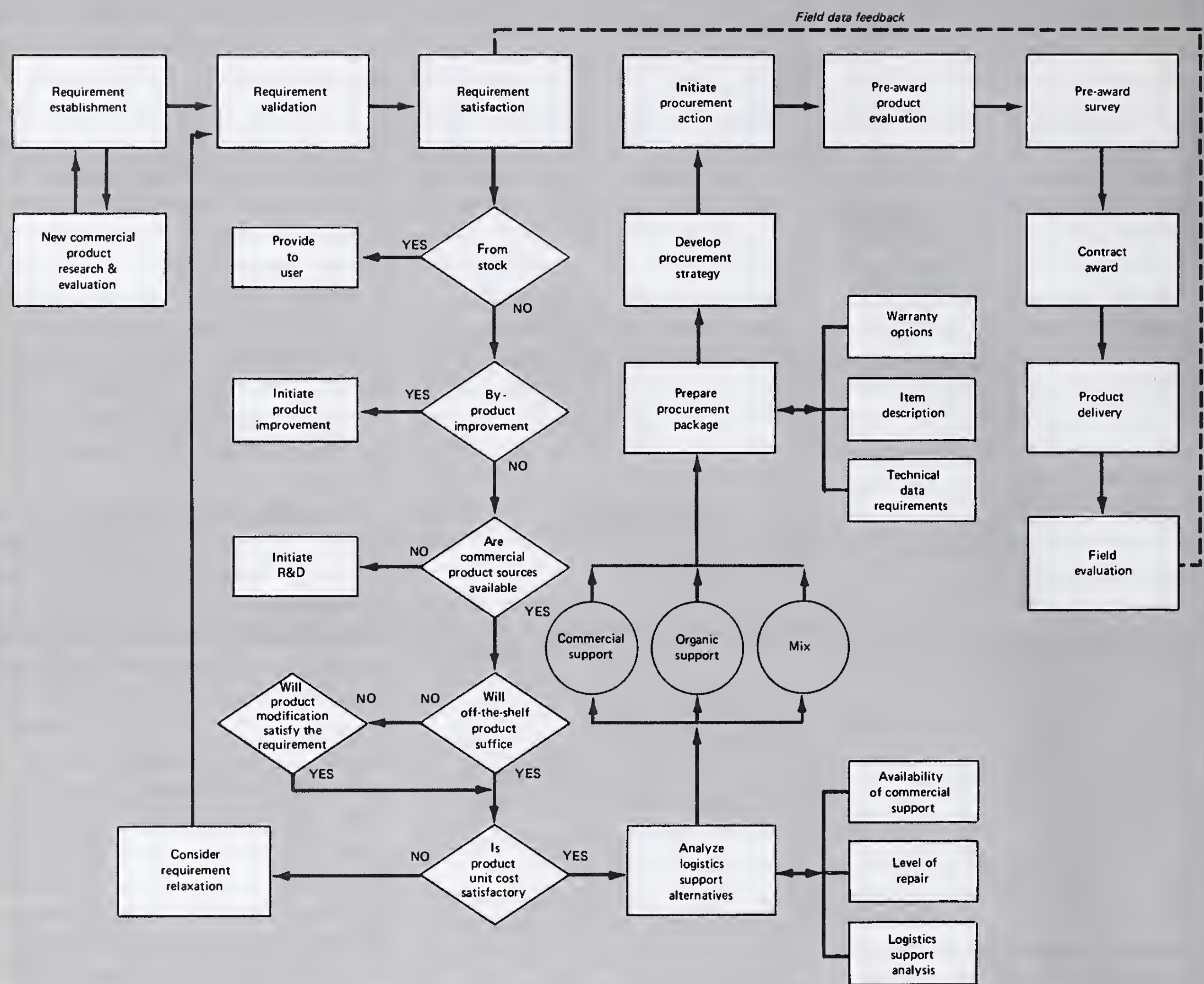
Guidelines were provided which address each stage of the acquisition process from establishment of the requirement to evaluation of the fielded product. Figure 1 on p. 36 illustrates the various decision points in the cycle and the factors to be considered at each point. DoD Component program managers assigned responsibility for satisfaction of the user requirements included in the pilot program will utilize CCAP guidelines to assist them in the many and varied decisions each must make as the acquisition process progresses.

An OSD-DoD Component task group, formed to establish CCAP, will serve as a forum for the discussion of problems and issues encountered by program managers in their effort to meet requirements by means of commercial, off-the-shelf procurement. Proposed problem solutions will be developed and provided to appropriate offices and agencies for resolution on an expedited basis. The objective will be to prevent delays resulting from any unique procedures or techniques employed in the process of buying commercial.

Where it is obvious that solutions would involve a considerable period of time—for instance, requiring changes to the Armed Services Procurement Regulations, military department directives and instructions, or government statutes — waivers for the duration of the pilot program will be obtained. Two such waivers have already been promulgated by the Assistant Secretary of Defense (Installations and Logistics).[1] The pro-

[1] *Now Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics).*

Figure 1. CCAP Acquisition Methodology



visions of ASPR 1–1202(a), which deal with military specification requirements, have been suspended. In addition, authorization has been granted to DoD Components to deviate from the use of federal specifications in procuring certain commercial items included in the pilot program.

A CCAP workshop has been scheduled for late 1977 for those government and industry personnel involved in the pilot program, as well as individuals knowledgeable in the field of commercial products. The purpose is to bring to the workshop expertise in such areas as commercial product specifications, procurement techniques, testing, quality assurance, reliability, and warranties.

Two basic objectives will be satisfied by the workshop.

- Experience accumulated during the pilot program will be reviewed and recommendations will be developed by the working groups to refine or revise pilot program guidelines as required.
- Workshop conclusions and recommendations, coupled with pilot program results, will spawn long-term commercial acquisition policy and methodology which will be more compatible with that employed by the private sector.

If DoD is to be a customer for commercial products, it must act more like a commercial customer. To do so, the Defense Department must understand the commercial business world and its modus operandi. The acquisition process can then be adjusted accordingly without los-

ing sight of the fact that there will always be differences between DoD as a user of products and the commercial customer as a user of products.

Program Considerations

The pilot program must stimulate program managers, engineers, procurement specialists, and logisticians to explore every avenue leading to the acquisition and use of commercial products. Only in this way can a broad range of new techniques and procedures be tested for viability and legality against existing policies, methodologies, regulations, and statutes.

In the requirements phase, caution must be exercised not to overspecify or underspecify a requirement. The dangers inherent in either practice are significant. In the former, adversity takes the form of a specification which no commercial supplier can satisfy without redesign and redevelopment; in the latter, eagerness to procure a commercial item known to be readily available can result in the user receiving an inadequate product. There are horror stories on record which illustrate both extremes. Use of the so-called F^3 (Form-Fit-Function) performance specification will be encouraged, allowing potential suppliers considerable latitude with respect to product design, thereby stimulating the private sector to compete where they would not if faced with a military design specification.

To utilize commercial products effectively, DoD needs a much more finely tuned knowledge of the use environment to permit realistic assessment of the suitability of various products with respect to that environment. This requires greater use of mission and environmental profiles.

The procurement phase is also vitally important to a successful commercial acquisition. Procurement strategies and incentives must be employed which more closely approximate private-sector strategies and incentives. However, it must be recognized that DoD is a rather unique buyer when compared to a Sears, Roebuck and Company. The objective is to mirror Sears as a buyer to an extent consistent with the satisfaction of customers whose requirements for products and materiel often bear little resemblance to those of "Harry Homeowner." Warranties are a good example of DoD uniqueness. Seldom will the standard commercial warranty be suitable for military systems and subsystems, where the possibility exists for a time lag between acceptance by the government and installation for use. On the other hand, warranties may be perfectly adequate when applied to DoD requirements for consumables with high-turnover histories.

Often the decision is made to take the R&D path because there is insufficient knowledge relative to the availability of commercial products which satisfy a given requirement. To avoid this pitfall, DoD Components will be routinely required to conduct extensive market research prior to initiating the procurement process. Constraints imposed by the Armed Services Procurement Regulations must be immediately surfaced to permit development of petitions for permanent ASPR changes.

Finally, CCAP will carefully develop necessary policies and methodologies to ensure objective, quantitative analysis of all possible alternatives prior to any organic versus contractor support decision with respect to repairable products. Of paramount importance will be the development of a workable maintenance concept based primarily on availability and resultant reliability and maintainability requirements. This logistics decision must be cost-effective; thus, trade-offs may be indicated. Unfortunately, buying commercial will normally fix as constants such cost drivers as R&M, thereby limiting the trade-offs to logistics parameters. Pilot program guidelines call for the judicious use of logistics support analysis and level of repair analysis as tools in evaluating logistics support alternatives.

With respect to the thirty different consumables presently included, the CCAP and CISP pilot programs will ask and answer the following questions:

- Must the consumable product be described by military or federal specification, or will a commercial specification or purchase description be adequate to ensure delivery of a satisfactory product?
- Is it necessary to centrally procure, manage, and store a given consumable, or can the item be locally managed with concomitant use of the commercial supply and distribution system?

CCAP Impact

The Commercial Commodity Acquisition Program will strike at the heart of existing policy and procedure within DoD Components. It will impact logistics support, cost, standardization, and all aspects of the acquisition

process. Although there are entrenched functional elements who paint the impact as totally negative, just the opposite is true. The acquisition process will certainly be improved if it is structured to permit an objective look at commercial, off-the-shelf products. Unit production cost and cost of ownership will be favorably impacted if expensive and time-consuming R&D can be avoided. And CCAP will drive the establishment of a more flexible logistics policy, the infusion of which will undoubtedly result in cost-effective and timely logistics support of DoD material.

While alarmists stress that CCAP is the antithesis of the Defense Standardization Program, nothing could be further from the truth. There is absolutely no reason why DoD cannot standardize on an off-the-shelf commercial product provided such an effort does not impede technological improvement of the product. Just as not every product should be standardized, not every DoD requirement can be satisfied by a commercial, off-the-shelf product. The goal is to satisfy a user need in a cost-effective manner by utilizing those techniques that produce the desired result.

A Few Success Stories

There exist today some outstanding examples of DoD programs which involve commercial products. One of these includes Materials Handling Equipment, where the trust is twofold: to reduce the number of military specifications for MHE; and to reduce the number of military-peculiar requirements in those specifications. So far, there have been percentage reductions in Army, Navy, and Air Force MHE specifications of 51 percent, 12 percent, and 83 percent, respectively. Even more important is that commercial-equivalent MHE is now often able to satisfy military needs without modification. Furthermore, the services are consolidating their requirements annually, the results of which are increased responsiveness from suppliers and reductions in unit cost.

The Navy has a very viable program called TELCAM, or Telecommunications Equipment Low Cost Acquisition Methods, whose objective is:

> *to provide reliable telecommunications equipment at lower in-service costs through methodologies which precisely translate operational requirements to technical parameters using alternatives to select the best acquisition mode, maintenance philosophy and logistics support procedures.*[2]

This TELCAM objective closely parallels those of CCAP. It is a long-term effort, with phase one addressed to the telecommunications environment aboard surface ships of all operating classes.

Temperature-humidity, vibration, and electrical transient response data were collected over a 12-year period under a program entitled "Shipboard Equipment Environmental Data Study (SEEDS)." From this data base a TELCAM screen was developed which is actually a tailored version of MIL–E–16400. A market survey was then conducted to determine the availability of commercial electronics equipment to meet various shipboard requirements. Of six different types of available commercial equipment screened under TELCAM, four passed and two failed.

Results of the screening, shown in Figure 2, demonstrate that well-designed commercial equipment will function effectively in the real-world military environment, and that a selection screening procedure is essential to eliminate commercial equipment with severe design weaknesses.

Figure 3 illustrates the cost difference between TELCAM commercial equipment and equipment identical in function, but militarized for service use. While the militarized cassette is far more rugged than the commercial model, the cost ratio is an unbelievable 48 to 1. In this case, the government is paying for features it doesn't need because the military design far exceeds the requirements; moreover, the militarized recorder requires a waiver of MIL–E–16400 temperature-humidity requirements.

The commercial and militarized telephones provide a better comparison. Here the militarized telephone, despite the fact that it was designed for rugged military operation, proved unreliable, and was successfully substituted by its commercial counterpart.

The results of the Navy TELCAM effort to date confirm that there are dramatic cost savings inherent in buying and using commercial products; and,

[2] *R. Leffler, "Telecommunications Equipment Low Cost Acquisition Methods (TELCAM)," NELC Technical Document 335, Naval Electronics Laboratory Center, San Diego, CA, July 1974 (available through the Defense Documentation Center under accession number A001713).*

Figure 2. Results of Available Commercial Electronics Equipment Tested to Meet Various Shipboard Requirements

Equipment	Test Results
Recorder	Passed; also passed MIL-E-16400 with modified temperature-humidity.
Floppy disk	Passed.
Telephone	Passed; slight modification to cradle handle.
Plotter	Passed; slight modification adding absorbent spacers between circuit cards and chassis.
Transceiver	Failed own specification and temperature-humidity. Extensive modification required. Rejected.
Color TV	Failed vibration, electrical transient response, and humidity. Extensive modification required. Rejected.

just as important, commercial products can and do perform in the real-world military environment.

The MACI Program

The Army has instituted a program known as Military Adaptation of Commercial Items. The thrust of MACI is to meet requirements with commercial off-the-shelf equipment where possible, but without ruling out commercial equipment which will do the job with minor modification.

A very successful application of MACI involved the Army's procurement of a navigational receiver to be installed in all Army helicopters. A two-step procurement for approximately 5,000 receivers initially resulted in a response from six potential suppliers, all of whom had commercially designed, general aviation receivers available off-the-shelf. Test and evaluation narrowed the respondents to four. The award was then made based on the lowest bid price. Included in the solicitation was a requirement for a Reliability Improvement Warranty. The warranty agreed upon was for 4 years at 2.6 percent of unit cost; thus, the contractor assumed total logistics support with a distinct incentive to improve equipment reliability over that time frame.

The equipment was delivered and a mean-time-between-failure reliability requirement of 750 hours was met. The Army estimates a per-unit cost savings of $4,700 when compared to a militarized version of the same receiver, coupled with the elimination of a 3- to 5-year R&D effort and attendant nonrecurring costs. In addition, cost-effective logistics support was achieved.

Two points relative to this procurement should be mentioned. First, modifications for electromagnetic interference and shock were required to the basic off-the-shelf receiver. The contractor was able to implement them without disrupting his production line or seriously affecting unit cost savings. Second, the maintenance concept for the receiver coupled with the RIW clause enabled the Army to acquire cost-effective logistics. While another logistics decision must be made 4 years from now, there is little reason why the RIW clause could not be renegotiated for the remaining receiver life. Most importantly, the Army has the option to develop organic logistics support or to continue with contractor support, an option which would not have been available had the decision been made at the outset to go with organic logistics support.

Figure 3. Two Examples of Cost Differences Between Commercial and Militarized Equipment

	Commercial	Military
Cassette recorder	$167	$8,000
Telephone	$ 42	$ 70

Inertia a Problem

Any change in traditional thinking and concepts is faced with institutional inertia resisting the change. Coupled with this are the socio-economic problems which arise when "empires" and "rice bowls" are threatened. Unfortunately, CCAP faced each of these; but as the advantages and payoffs associated with a viable commercial acquisition program accrue, these problems should disappear.

On the other hand, the pilot program will expose certain technical problems and issues which will require innovation and foresight if they are to be resolved effectively. Product performance is one potential problem area. Why? Because DoD can exert little or no design control over commercial, off-the-

shelf products, and because compromise of a military requirement is often not possible. Performance includes not only such design parameters as range and accuracy, but also reliability and maintainability. It is appropriate to focus on these latter factors because they often take a "back seat" to the more glamorous design characteristics.

Due to the lack of control over R&M design when dealing with a commercial, off-the-shelf product, safeguards must be established through some form of test and evaluation, or through assessment of supplier data which would tend to support his R&M claims, coupled with various contractual provisions such as RIWs and conditional acceptance based on field evaluation. The steps taken to ensure achievement of reliability and maintainability requirements will vary on a case basis. Take, for example, one of the Navy's pilot program candidates, Integrated Transit/OMEGA. This equipment will be installed aboard surface ships and tactical submarines, and will therefore require service approval.

Service approval is based on successful operational test and evaluation in the real world, and is prerequisite to the production decision. In this case, production go-ahead could then be based on test and evaluation, coupled with review and verification of supplier reliability data. Should supplier R&M data prove inadequate or nonexistent, a more extensive test effort would be required. Something similar to a TELCAM screen integrated into a reliability test and maintainability demonstration would be one possibility. Operational test and evaluation is another, because some assessment can be made not only of reliability, but also of maintainability, dependability, human engineering, and supportability.

Including RIW in the solicitation would protect the government against unreliability while incentivizing the supplier to improve product reliability during the warranty period. A supplier's acceptance of a fixed-price production contract with an RIW provision is generally an indication that he has some degree of confidence in the reliability and maintainability of this product.

The government must also ensure that the supplier has in place a satisfactory quality assurance program. This cannot be accomplished by an arbitrary insertion of MIL–Q–9858 into the contract. Rather, this may be done by pre-award survey; by including in the solicitation quality assurance requirements tailored to the specific user requirements; and by use of "Commercial Market Acceptability" as a prerequisite to award.

As defined by the Office of Federal Procurement Policy, Commercial Market Acceptability:

> *. . . relates to commercial products that are currently marketed in substantial quantities for the general public and/or industry. These marketed items involve commercial sales that predominate over Government purchases. To have become acceptable in the market place, products must have been priced competitively and performed acceptably, as judged by a wide range of users.*[3]

There is always the possibility that use of this proviso will result in protests, but it seems to be a reasonable condition acceptable to legitimate suppliers. Certainly the majority of commercial off-the-shelf products being marketed by reputable manufacturers should eventually be able to meet the test of commercial market acceptability.

The Specification Problem

Basic to the entire acquisition process is the problem of overspecification of requirements. In one instance, a user requirement for a radio receiver was being converted to a definitive specification. The specification writer was aware of at least six commercial, off-the-shelf receivers which would satisfy the basic requirement. Unfortunately, he chose to include in the specification the best features from each of them. As a result, he had a specification for a hybrid receiver which didn't exist, and which far exceeded the baseline requirement.

For this problem to be solved, the government must analyze the commercial specification associated with an off-the-shelf item; if the baseline user requirement can be met, the commercial specification should be used. Industry, on the other hand, must improve their specifications and purchase descriptions so that they are useful to DoD as well as the private sector.

The blanket application of

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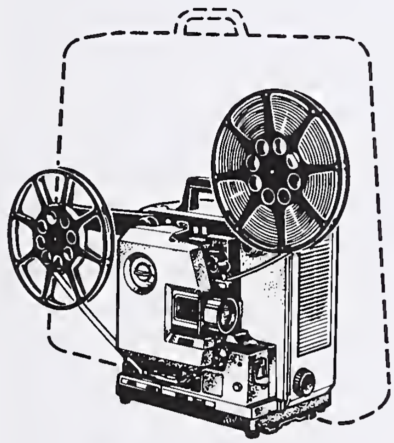
[3] *OFPP Memorandum to the Secretary of Defense, Administrator of Veterans Affairs and Administrator of General Services, 6 December 1976, subject: Incremental Implementation of Policy on Procurement and Supply of Commercial Products—Planning and Analysis Phase.*

"Half a Loaf Isn't Necessarily Better Than None"
or
"Good Try, But No Blue Ribbon"



Some time ago, a DoD Component had a requirement for a number of motion picture projectors. The requirement was naturally directed to the organization responsible for satisfying the need.

There, the first step was to express the requirement in a manner suitable for procurement. Rather than take the traditional "blinders-on" approach of writing a military specification for the projector, this organization made a determined and admirable effort to be technically aware and cost conscious. A performance-type specification was prepared for the procurement. Then the commercial marketplace was surveyed, revealing that several commercial motion picture projectors which met the requirement were available off-the-shelf.

At this point, the situation soured. In interpreting that portion of the requirement dealing with the projector storage container, someone decided that full military specification treatment should be applied. This conclusion was reached because the projector was to be utilized in all kinds of environments and therefore required protection against such associated adversities as rain, snow, hail, fungus, and temperature extremes. As a result, a protective case was procured which would meet all these environmental requirements.

The effect was immediate and catastrophic. Competition was severely reduced when several suppliers either could not or would not respond to the solicitation because of the special case specified. Worse yet, the cost of the protective case exceeded the cost of the motion picture projector by nearly a factor of eight.

The basic question that must be asked is: Was that special case really necessary when, in all probability, 90 percent of the projectors would be stored and operated in a benign environment regardless of the actual geographic location? This example dramatically illustrates the importance of thoroughly understanding requirements and thereby avoiding overspecification.

specifications and technical data requirements not only drives acquisition costs astronomically upward but also turns off the commercial supplier. The solution is simple, but difficult: tailoring must become routine. Although this involves time and effort, it is a necessity during this time of funding austerity.

Industry can help in this area by improving the quality of its technical data, maintenance publications being a case in point. They must be written with an understanding of both the military's concept of conducting maintenance and the current capabilities of military technicians. All too often commercial publications are written for contractor field engineers rather than technicians. But it is a two-way proposition, for the government bears the responsibility for publicizing such relevant information.

Armed Services Procurement Regulation constraints and DoD Component regulations and procedures are known generic problem areas. One of the basic objectives of the CCAP pilot program is to expose this type of problem so that immediate corrective action can be taken. It is hoped that industry will aggressively pursue their role in this area through such organizations as the Electronic Industries Association, Aerospace Industries Association, and National Security Industries Association.

Proprietary data and profit margins also represent potential problems. The government must accept industry's position on proprietary data just as the commercial customer does if it expects responsiveness to solicitations. Commercial price quotes must be acceptable to the government. Profit margins cannot be dictated to the commercial supplier. Price breaks and discounts can best be obtained by consolidating requirements and invoking procurement techniques which incentivize suppliers and reflect DoD's role as a major source of long-term business.

Tradition and Emotion

An undercurrent exists among military users which reflects a certain lack of confidence in commercial products, especially the more sophisticated ones. Part of this feeling is real, part imagined; but it is prevalent enough that it must be addressed by commercial suppliers solicitous of DoD business. Among the ways to reduce and eventually eliminate this wariness are for the commercial suppliers to:

- Develop an awareness of the subtle and not-so-subtle differences between his commercial customers and DoD as a customer, trying to narrow the gap.
- Achieve commercial market acceptability of his products, which is simply good business regardless of the type of customer.
- Establish and maintain a viable R&D program, instead of expecting DoD always to bear the brunt of this burden.
- Design reliability and maintainability into his product from the beginning, keeping in mind that these design characteristics are much more than emotional factors when he is providing a product that will contribute to the capability of the United States to defend itself.
- Establish and maintain a sound quality assurance program, since spending money to design a product which meets all performance requirements is worthless if the performance levels achieved degrade on the production line.

One final problematic issue involves logistics support, where emotionalism and traditional thinking among certain elements of the military are rampant, and often with good reason. Adequate and timely logistics support to major weapon systems and subsystems has traditionally been "a dollar short and a day late." With the advent of the integrated logistics support concept and the realization that adequate support is part and parcel to operational readiness, significant progress has been made in terms of funding, planning, and managing logistics support. The

result has been an order of magnitude improvement in system support capability across-the-board.

Consequently, any program which appears to threaten this achievement is subject to attack, and the potential use of contractor logistics support inherent in CCAP represents just such a threat. This is because the support capability of the commercial supplier is unknown, suspect, and even nonexistent in some areas. Thus, industry's responsibility is to access its logistics support capability in terms of DoD's requirements, and to take action as appropriate. DoD Components, on the other hand, must understand that organic support is often neither cost-effective nor appropriate, and as such is not the only answer. A learning curve is involved, but the potential exists to climb the curve; it is a matter of attitude, dedication, and determination.

CCAP and Other Programs

There are many programs throughout the federal government which complement CCAP objectives, but two such programs are worthy of mention. The first is a commercial product policy statement promulgated by the Office of Federal Procurement Policy of the Office of Management and Budget on May 24, 1976:

> *The Government will purchase commercial, off-the-shelf products when such products will adequately serve the Government's requirements, provided such products have an established commercial market acceptability. The Government will utilize commercial distribution channels in supplying commercial products to its users.*

The first phase in implementing this policy involves examining groups of consumable products under the management control of DoD, the General Services Administration, and the Veterans Administration to determine whether these items can be procured by commercial specifications rather than by military or federal specifications. Also to be determined is whether the commercial supply and distribution system can be used to provide these items to the user where and when needed. Although CCAP was initiated 5 months prior to the issuance of the OFPP commercial policy, it is structured to be compatible with and responsive to that policy.

Another important DoD program which complements CCAP is the effort of the Defense Materiel Specifications and Standards Office to adopt industrial specifications and standards. The concept here is to eliminate military specifications wherever industrial specifications will meet DoD's requirements. When one considers that there are over 40,000 documents involved, the enormity of the task is apparent; but much progress is being made.

Effort Will Produce Results

The impact of a viable OSD Commercial Commodity Acquisition Program is far-reaching, and the potential payoffs to both DoD and industry are extremely significant. Such benefits as R&D cost savings and time avoidance, lower unit production costs, a shorter acquisition cycle, increases in competition, and improvements in the industrial base cannot be discounted. It behooves everyone involved in satisfying DoD requirements to fully support this program and make it a success. **DMJ**

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Tapping Organizational Functioning in the Federal Sector Through Systematic Survey Research

Through the Civil Service Commission's use of surveys, government employees' perceptions of their working life will be assured of adequate representation when management finds it necessary to make changes in organizational functioning.

During the past few years there has been a significant growth in the number of employee surveys throughout the public and private sectors. For example, the Civil Service Commission surveys employees throughout the federal government concerning their perceptions about various aspects of their work environments, while General Motors and Sears are just two of the many major corporations which have developed extensive personnel survey programs.

Results from these surveys are used to determine how employees view their work environment in terms of such factors as management practices and policies, communications effectiveness, and work group relationships. Indices of current organizational health and employee job satisfaction are frequently derived from such survey data. Moreover, surveys have recently become integral components of organizational development programs designed to enhance organizational functioning through the application of behavioral science-based intervention techniques.

Functions of Organizational Surveys

Organizational surveys serve a number of functions within an organizational development program. They can serve as a diagnostic means to identify problem areas which can be addressed through OD strategies or direct management action. The data itself can provide a central focus for such OD strategies as participative problem solving, where work group members examine the data and subsequently develop their own approaches to resolving problem areas.

Surveys can also provide one source of data for evaluating the effects of OD strategies. For example, they can be readministered following the conclusion of the OD program, and the data collected can be compared with data obtained prior to the program introduction to detect

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Opinions expressed herein are those of the authors and not necessarily those of the Department of Defense.

program-induced changes. Employee perceptions of their own work motivation and effort as well as their job satisfaction are useful focal points in making such evaluations.

Finally, evaluations of the current health of an organization before and after the introduction of an OD program can be conducted by comparing survey data collected in the focal organization with normative data collected in similar organizations using the same survey instruments.

In the past, the primary function of surveys was to measure the job satisfaction of employees in terms of various job and work environment dimensions. Ronan[1] noted seven basic dimensions of job satisfaction which seemed to appear most frequently in survey results; these are:

- The content of the work itself.
- Direct supervision.
- The total organization and its management.
- Opportunities for advancement.
- Pay and other benefits.
- Co-workers.
- Working conditions.

A prime example of such a survey is the Job Description Index developed by Smith *et al.*[2] which considers five such dimensions.

However, OD programs frequently require a wider range of measures which provide more detail on the nature of employees' perceptions, motivations, behaviors, and satisfactions. Moreover, research attempting to relate general job satisfaction measures to performance has been relatively unsuccessful. Therefore, instruments are now being developed which deal with more specific aspects of the job, work environment, and total organizational setting.

The intent in developing these instruments is to provide as complete a data picture as possible of how employees respond to their jobs and work environments. Examples of instruments developed with this in mind include the Michigan Organizational Assessment Package from the Survey Research Center at the University of Michigan and the Survey of Organizational Climate at the Civil Service Commission.

These instruments tend to focus heavily on the effects which various aspects of the job and work environment have on employee motivation. For example, as to supervision, emphasis is placed on the degree to which a supervisor adequately motivates his subordinates through the effective administration of rewards for good performance. The delineation of various rewards beyond the more traditionally considered ones such as pay and promotion can also be explained as potential motivators.

Frequently, organization or job-specific content may be introduced into the survey to tap certain dimensions more effectively. For example, specific tasks or activities might be considered in order to determine the extent to which they are viewed as challenging or even necessary to effective employee performance. In addition, measures of work effort have been developed and incorporated into surveys such as the Work Environment Questionnaire at the Army Research Institute.[3] These measures show

[1] *W. W. Ronan, "Individual and Situational Variables Relating to Job Satisfaction,"* Journal of Applied Psychology Monograph, *September 1970, pp. 1–31.*

[2] *P. C. Smith, L. M. Kendall, and C. L. Herlin,* The Measurement of Satisfaction in Work and Retirement *(Chicago: Rand McNally, 1969).*

[3] *J. R. Turney and S. L. Cohen, "The Development of a Work Environment Questionnaire for the Identification of Organizational Problem Areas in Specific Army Work Settings," Technical Paper 275, Army Research Institute for the Behavioral and Social Sciences, Arlington, VA, 1976 (available from the National Technical Information Service under accession number A028241).*

potential both for tapping how much effort employees expend performing various work activities and for examining various situational factors such as the work group and organizational policies which may either aid or restrict the total effort.

CSC's Approach to Survey Development

There are several basic assumptions underlying surveys that are used as part of OD programs:

- The items in the survey accurately and inclusively measure employee perceptions, motivations, and satisfactions in all cultural organizational areas.
- Certain relationships exist between the survey items and actual on-the-job behaviors, performances, and ultimately, organizational effectiveness.

The survey research and development program at the Civil Service Commission addresses these two assumptions and assures that they are met within the survey instruments being developed for use throughout the federal sector. The steps being followed include the generation of sets of survey items which seem to measure important dimensions of an employee's job and work environment. Conceptual models are used as a guide in delineating those dimensions to be addressed in the survey.

One such model (Figure 1) shows the relationship between employee motivation and various work environment dimensions. This model postulates that various aspects of an employee's work environment influence the extent to which that person can fully express motivation in actual work effort and performance.

Through a series of survey administrations, data analyses, survey modifications, and re-administrations, one can produce instruments which satisfy the first assumption of accuracy and inclusiveness. At this stage the survey could be used to obtain data from employees in one organization which could be compared with data from another organization. The health of one organization could be compared to that of one or more other organizations, but it would be impossible to determine on an absolute basis how effectively any one organization is functioning.

The second assumption is more difficult to accomplish, but is equally important if the survey is to be useful in an OD program where the ultimate objective is to enhance organizational functioning. This research effort involves the following:

- The determination of relationships between employee survey responses and independent measures of employee effort and performance.
- The delineation of situational factors which reduce or increase these relationships.
- The establishment of the extent to which survey response-performance relationships generalize across various agencies in the federal sector.

The primary initial focus in this research is on the delineation of independent measures which are sensitive to changes in employee motivation and performance and are acceptable to management as indicators of effective organizational functioning.

Survey Use Within the Army

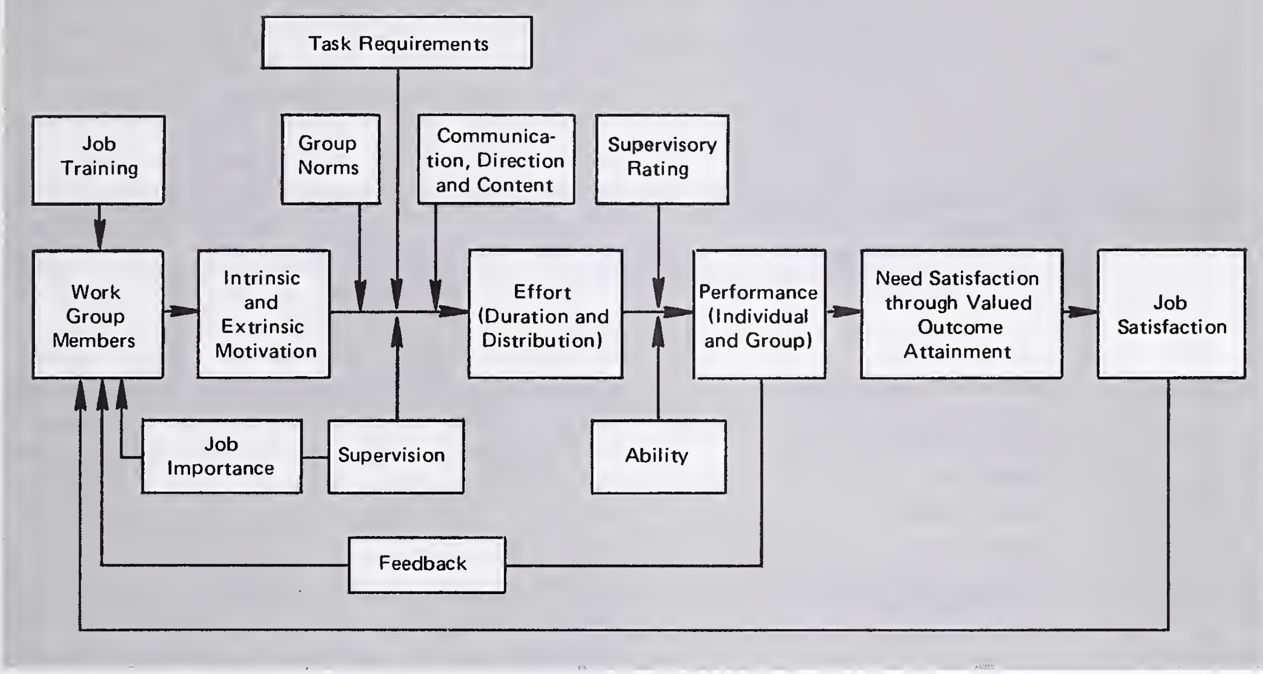
Recently a survey was used as an integral component of an OD program at an Army field communications facility. The survey used was the Work Environment Questionnaire,[4] which was designed specifically for this OD effort. Serving all of the functions described earlier, the WEQ provided a means to identify organizational problem areas; its data were a focus for participative problem-solving sessions; and it served as one source for evaluation of the impact of the OD program.

Several unique features were built into the WEQ. One of these was the introduction of a section where respondents were asked to estimate how they distributed their work time among various tasks or activities (see sample in Figure 2 on p. 48). Data obtained were compared with formal tasking requirements to determine the degree of consistency between formal standards and actual soldier activities. The activity distributions for high and low performers as indicated by independent performance criteria were also compared to determine adjustments in training procedures which might encourage poor performers to better utilize their work time.

Another unique feature of the WEQ was the development of different forms for subordinates

[4] *Ibid.*

Figure 1. Theoretical Organizational Model



and supervisors which permitted interesting comparisons of perceptions across levels. For example, supervisors were asked to estimate how their subordinates distributed their time across activities, while subordinates were asked to estimate how their bosses distributed their time.[5] These data were introduced into group problem-solving sessions where they served as the focus for comparisons of perceptions between supervisors and subordinates, discussion of reasons for discrepant perceptions, and increased understanding of how and why various amounts of time were required for specific activities. Similar types of between-level comparisons were also made for other work environment areas such as the utilization of specific communications channels and the feedback of evaluations for good and poor performance.

The use of the WEQ as a diagnostic instrument in this study resulted in the identification of the following organizational problem areas:

- The lack of peer group norms which encourage good performance.
- Insufficient performance feedback.
- The need for training in supervisory techniques.
- Role ambiguity and conflict.
- Inadequate intergroup communications patterns.
- Lack of motivating job content.
- Ambiguous performance evaluation strategies.

An OD program was implemented to address these various problem areas, and the data continued to play an active role in many group problem-solving activities.

At the conclusion of the OD program, evaluations were made of the impact of the interventions themselves. Analyses of survey and performance data collected before and after the program yielded a number of significant effects, including a 40 percent increase in certain of the objective performance criteria. The survey data indicated improvements in such areas as proper monitoring of work performance, presence of clear performance goals, effective assignment of work tasks, more participation in the development of work methods, and

[5] *The utilization of such time measures is described in more detail in J. R. Turney and S. L. Cohen, "Managing Time Effectively: The Worker's Perspective,"* Personnel, *November 1976, pp. 576–79.*

Figure 2. Work Time Distribution

Instructions: This section focuses on a number of activities which you perform during an average workday. Please look over these activities and then estimate as well as you can the percentage of time you spend performing each one. In deciding on your responses, you should consider your activity during a workday when traffic is fairly heavy. You should also focus on the operator position with which you are most familiar. Make certain that your percent time estimates approximate 100%. An hour-to-percent conversion guide is provided below to assist you in making these estimates. Your careful and honest response to each item would be most helpful.

Time	Activity
______%	Searching for assigned cases.
______%	Searching for nonassigned or unidentified cases.
______%	Copying cases.
______%	Monitoring cases.
______%	Servicing cases.
______%	Giving and receiving case information with other personnel.
______%	Using work aids (e.g., log book or pass-on book).
______%	Resting between cases on position.
______%	Taking work breaks away from activity center including meal time.
100 %	

Conversion Guide (8-Hour Workday)

2 hours	=	25% of time
1 hour	=	12% of time
30 minutes	=	6% of time
15 minutes	=	3% of time
1 minute	=	1% of time

alteration in the time devoted to certain productive work activities.[6]

What's Ahead

The WEQ example indicates the usefulness of survey data as part of an OD effort; however, the WEQ was specifically designed for that study. Extensive developmental research is being conducted by CSC's Organizational Psychology Research Section to produce sound survey instrumentation and procedures for OD efforts throughout the federal sector. This research not only will focus on item content itself, but also will consider the most appropriate format for items; procedures for use in developing item content describing unique characteristics of a specific work setting; and standardized, simplified procedures for analyzing data to provide organizations with meaningful, easily interpretable survey results.

Moreover, the Organizational Psychology Section plans to expand the data base across a range of federal organizations and utilize this information in revising models of employee motivation and organizational functioning within the federal sector. As this research progresses, CSC also hopes to develop modules which will focus on specific organizational areas and provide a unique survey and set of OD procedures to diagnose and address problems in these areas. For example, there would be separate modules for such areas as communications, supervisory control, and motivation.

Increased importance must be given to employee perceptions of the quality of work life. During the 1970's and 80's, more and more emphasis will be placed on making work a satisfying and enriching experience. The challenge to achieve this objective will also increase as the average education level of Americans continues to rise. The utilization of soundly developed surveys can aid this effort by assuring that the actual concerns and perceptions of employees are being adequately represented when changes in organizational functioning are introduced. DMJ

[6] *A more complete description of this program, entitled "Impact of Organizational Development in the Army," is currently being prepared for publication by S. L. Cohen and J. R. Turney.*

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Advanced Development Technology Programs: Do We Need A New Funding Approach?

The message of this article is that a generally accepted system of funding advanced development technology would benefit from some major changes.

The spectrum of research and development effort in the Air Force Systems Command spans the complete gamut from research into basic phenomena to the full-scale development and acquisition of advanced systems. Allocating resources to the various elements of this spectrum is a highly complex process wherein maintaining a balance of effort is always sought while also accommodating the dictates of high priority programs (Figure 1 on p. 50).

As programs move from research and exploratory development through advanced development to engineering and systems acquisition, the level of engineering risk, specificity of end product, and flexibility of funding or schedule perturbations all vary considerably. At the research end, the degree of uncertainty is very high, with ill-defined results expected, justifying a philosophy of "best effort" level of funding unconstrained by schedules. At the systems acquisition end, the level of risk is deliberately held minimal, with detailed design specifications, performance, and delivery schedules all controlling required funding to a predominant degree.

In view of the wide range of R&D effort with its variety of characteristics, it is not difficult to see that funding allocation decisions at the two extremes are fairly straightforward. Research is given a fixed amount of dollars, and approved systems are essentially funded to meet the requirement. Between those two points, however, the decision is not so obvious and often is accomplished by intuitive, educated guess and a "squeaking wheel" philosophy. If a program is a little to the left of center, the pressure is to level-fund it. If it is to the right of center, the pressure is to fund it fully. And there are all shades of gray and opinions as to whether a program is left or right.

What should be done about the middle area? As noted in Figure 1, this area represents the advanced development category of R&D, falling short of systems-oriented programs but more advanced than higher risk, component-oriented efforts. The lower end of the advanced development category does include some higher risk, exploratory efforts, and the upper end includes some systems-oriented efforts. These generally fall into the left or right spectrum where the funding decision is easier to rationalize. This article, therefore, addresses only the center section of the advanced development spectrum.

In fiscal year 1976 over $200 million was expended by the Air Force alone for work in this center section, so the potential obviously exists for significant benefits from an examination of

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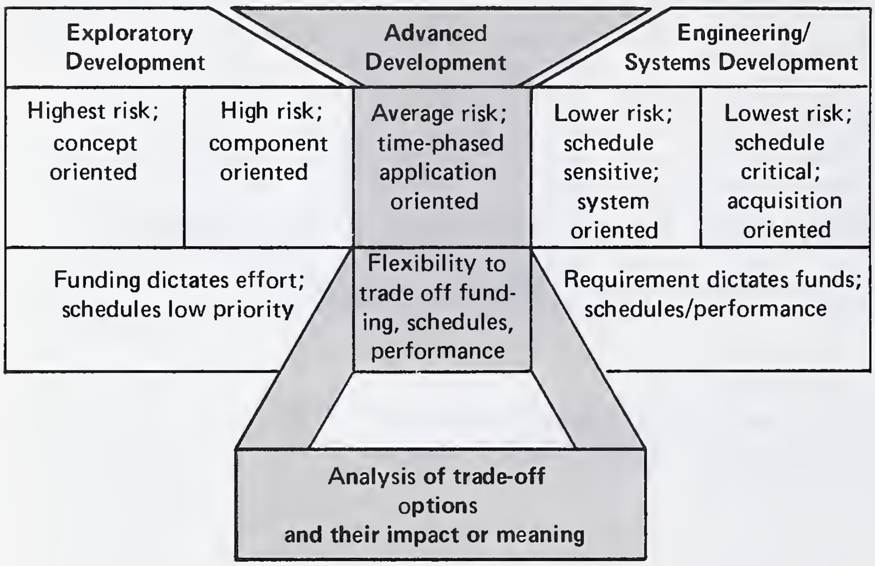
Opinions expressed herein are those of the author and not necessarily those of the Department of Defense or Department of the Air Force.

Figure 1. Development Program Characteristics



the most appropriate funding philosophy. The following are typical characteristics of this section:

- The basis for projects is fairly well established, such that a specific development product can be defined.
- A logical development approach can be formulated which provides for realistic forecasts of both schedules and costs.
- Considerable flexibility exists in selecting the desired end product to demonstrate, the schedule to be pursued, and the allocation of resources commensurate with such schedule.
- Funding for the area has tended to be level over the years, providing an overall constraint on the magnitude of effort that can be supported.

Because these characteristics could fit many R&D programs in any given situation, the conclusions drawn are also applicable to other areas having such characteristics.

At this point the questions might be posed: "How should one prioritize resource allocations for this area? Should project integrity be emphasized by supporting only as many projects as funds will permit to be pursued at their most optimum pace? Or should emerging technology be accentuated by starting projects at a low entry level to increase the number of new projects started, and hence provide a wider selection of efforts? Or should a broad base be stressed by resorting to more austere schedules and funding levels to reduce individual project annual funding requirements, thereby permitting more projects to be pursued?"

The answer is by no means as obvious as one might hope. It turns out to be the first approach; that is, fund and pursue programs at their optimum rate, forsaking the very real temptation to follow the second and third approaches. Since this conclusion may contradict ingrained perspectives, the following discussion develops the proof and discusses its consequences.

A simple example is employed to demonstrate the logic. First, however, the following fundamental assumptions must be made:

- Advanced development will be a continuing and important phase of the R&D cycle.
- Activity per se does not necessarily equate to accomplishment. Progress requires the exploitation of new developments, and this dictates not only the successful completion of programs on a timely basis, but also the continual periodic introduction and pursuit of new efforts.
- Overall funding availability will be at a relatively fixed level for the foreseeable future.

In developing the example, several parameters were selected:

- A steady-state budget is assumed to be at a fixed level and thereby becomes a planning constraint.
- The number of new program starts which can be initiated each year is viewed as a measure of progress, in that such provide insurance against obsolescence.
- The number of program completions per year is also viewed as a measure of progress.
- The schedule, or cycle of development, is a variable in the analysis.
- The number of programs pursued per year refers to the pipeline of projects being managed at any given time, and is viewed as a measure of activity.
- The total cost per program is an arbitrary constant in the example and represents the average cost of a variety of programs, each having individually varying costs.

Some thought was given to using actual programs, costs,

and schedules rather than a hypothetical "average" case to develop the example. Such an approach, however, might suffer from security constraints, be difficult to treat parametrically for analysis, and give rise to disagreement over the accuracy and circumstances of individual programs. Since the conglomeration of all "real" programs can be treated from an "average program" perspective, this was the technique employed.

Figure 2 represents the development of a basic funding trend for a hypothetical average advanced development project having a total cost of $20 million. For the sake of simplicity, all projects are assumed to have this price tag. It is further assumed that each project has what might be termed an "optimum" development schedule representing the most cost-effective sequence of events, and this is arbitrarily set at 4 years for the average project.

A representative distribution of the $20 million over these 4 years might be as shown in Figure 2. Alternatively, to satisfy the desire to accommodate more projects in a given year (the essence of the other candidate solutions), an austere schedule of 6 years is also shown, with a revised distribution of the $20 million. No penalty for non-optimum effects is taken at this time (i.e., the non-optimum program would obviously cost more than $20 million).

Figure 2. Basic Funding Trend
(millions of dollars)

	Year						
	1st	2nd	3rd	4th	5th	6th	TOTAL
Optimum Schedule	3	6	8	3			20
Austere Schedule	1.5	3.5	5	5	3	2	20

Figure 3. Optimum vs. Austere Program Cost Comparison
(millions of dollars)

	Year						
	1st	2nd	3rd	4th	5th	6th	TOTAL
Ten 4-Year Projects	30	60	80	30			200
Twenty 6-Year Projects	30	70	100	100	60	40	400

Figure 4. Funding Buildup
(millions of dollars)

4-Year Optimum Case

New Starts	1st	2nd	3rd	4th	5th	6th	
1st Year	30	60	80	30			10 Completions Per Year
2nd Year		30	60	80	30		
3rd Year			30	60	80	30	
4th Year				30	60	80	40 Projects Managed
5th Year					30	60	
6th Year						30	
Total	$30	$90	$170	$200	$200	$200	

6-Year Austere Case

New Starts	1st	2nd	3rd	4th	5th	6th	
1st Year	30	70	100	100	60	40	– 20 Completions Per Year
2nd Year		30	70	100	100	60	
3rd Year			30	70	100	100	
4th Year				30	70	100	120 Projects Managed
5th Year					30	70	
6th Year						30	
Total	$30	$100	$200	$300	$360	$400	

Program Options

If one assumes that the total funding budget will permit $30 million to be set aside each year to initiate new projects, it becomes evident from Figure 2 that this new-start level will permit 10 new 4-year optimum projects at a cost of $3 million the first year, or 20 new 6-year austere projects at a cost of $1.5 million the first year. The year-by-year funding to continue these projects is illustrated in Figure 3.

Starting twice as many programs will obviously double the cost by the time they are finished, but this additional cost is spread over more years, lessening the early-year impact. To depict this, Figure 4 presents a buildup of required annual funding to accommodate a total advanced development program based on starting new efforts each year at a constant first-

year level of $30 million. Two cases are shown: the 4-year optimum program starting 10 new projects per year, and a 6-year austere program starting 20 new projects each year.

An examination of Figure 4 reveals some obvious relationships and also some that are not as obvious:

- A steady-state budget is reached in a period equal to the development cycle.
- The projects completed per year equal the projects started per year.
- The projects pursued (managed) per year equal the projects started per year times the cycle.
- The steady-state budget equals the projects started per year times the total cost per project.

A further observation can be made if one assumes that a total program annual ceiling of $200 million exists. In such a case, it becomes obvious that major program adjustments will be necessary in the austere program starting in the fourth year. The trade-off of longer schedules for more projects works only during the build-up phase and reflects a false concept. Required adjustments usually involve a variety of actions such as postponing new starts and stretching schedules of ongoing programs so as to move the excess downstream. This results in creating what is referred to as a budget "bow wave." Figure 5 reflects the cumulative effect of such a bow wave as it is moved ahead one year at a time. The net effect is to disrupt the original planning for both new and ongoing projects.

Some initial conclusions can be drawn from these simple examples:

- The "progress" parameters (projects started and completed) directly determine the steady-state budget requirement (schedules are not a factor).
- The "activity" parameter (projects pursued) directly affects schedules (more projects mean longer schedules).
- Schedule variations cause a transitory effect on budget requirements but do not affect the steady-state requirement.
- Starting more programs than the steady-state budget ceiling can accommodate will create a budget bow wave and force eventual major adjustments.
- A much larger management structure is required to accommodate the expanded activity parameter caused by stretched schedules (120 projects versus 40).

Broadening Base

The preceding discussion illustrates the basic fallacies inherent in the two austere approaches vis-a-vis the optimum approach; it does not treat the case of a deliberately austere program designed to live within the steady-state budget constraints, but designed also to broaden the base of pursued programs. Consider the case where the $200 million ceiling still exists, but it is desired to proceed more slowly so as to increase programs pursued. Since the $200 million ceiling will support an average of only 10 new starts per year, the austere 6-year schedule will require only $15 million for start-up while increasing the pursued programs from 40 to 60.

The resulting build-up is depicted in Figure 6. A comparison of Figure 6 with Figure 4 provides the following observations, which are also summarized in Figure 7:

- The progress parameters are the same in both cases.
- The steady-state budgets are the same.
- Considerably more investment ($615 million versus $370 million) is required before output under the austere schedule.
- Fifty percent more projects are pursued and must therefore be managed each year in the austere case.
- The eventual cost of completing projects is the same.
- A perpetual, 2-year obsolescence factor has been introduced, coupled with a postponed debt of $195 million which must still be paid.
- A differential of completed programs will always exist in favor of the optimum schedule.

Considering these observations, it would appear the price paid for increased breadth of coverage (programs pursued) is greater obsolescence of the technology with no increase in technological output. Further, the austere schedules in reality reflect increased costs due to inflationary and inefficiency factors. Before rejecting this trade-off, however, one must evaluate the pros and cons of increasing pursued programs. Proponents of this approach reject the premise that project completions represent progress more than programs pursued, and maintain that one should opt for a program which includes the widest possible coverage of projects. To these individuals, the increased activity is viewed as being more important than the delayed completions on the contention that activity is also progress. Therefore, the proposition that ac-

tivity is progress needs to be addressed.

The first "activity" perspective is that a requirement exists to pursue a broad front in many technical areas in case a need should develop or a technical breakthrough that might be exploited should occur. The need is also cited to maintain a strong technological base and to increase advanced development programs promising significant contributions to systems capabilities. The viability of this position is largely negated by the following considerations:

• Advanced development is not breakthrough oriented. It provides the proof of concept, not the creation of it. Broadened coverage, therefore, does not enhance breakthrough potential.

• A strong technological base implies "level of effort" activity, which is fundamentally the basis of the exploratory development area of the R&D spectrum (Figure 1).

• Should an urgent requirement develop to accelerate a given program, it might still be constrained to an austere schedule by virtue of the crowded program and limited funding ceiling flexibility. In fact, it might be available sooner if accelerated as a delayed new start but on an optimum schedule basis.

• Little funding room can be expected through program terminations caused by failures. Since advanced development is a lower risk program, such failures would not likely occur until late in a program. Indeed, because of the shorter schedules, they would be determined sooner on an optimally scheduled program.

The second activity perspec-

Figure 5. Funding Buildup (millions of dollars)

6-Year Austere Case

New Starts	1st	2nd	3rd	4th	5th	6th	
1st Year	30	70	100	100	60	40	— 20 Completions Per Year
2nd Year		30	70	100	100	60	
3rd Year			30	70	100	100	
4th Year				30	70	100	120 Projects Managed
5th Year					30	70	
6th Year						30	
Total	$30	$100	$200	~~$300~~	~~$360~~	~~$400~~	
				$200	~~$460~~	~~$400~~	
					$200	~~$660~~	
						$200	$460

Figure 6. Broad-Base Program (millions of dollars)

6-Year Austere Case

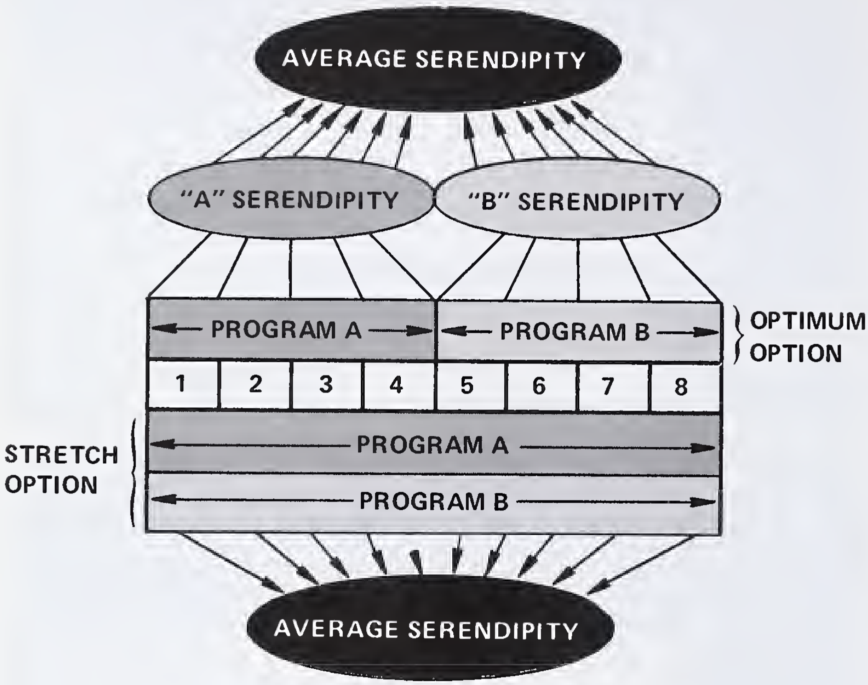
New Starts	1st	2nd	3rd	4th	5th	6th	
1st Year	15	35	50	50	30	20	— 10 Completions Per Year
2nd Year		15	35	50	50	30	
3rd Year			15	35	50	50	
4th Year				15	35	50	60 Projects Managed
5th Year					15	35	
6th Year						15	
Total	$15	$50	$100	$150	$180	$200	

Figure 7. 4-Year Optimum vs. 6-Year Austere (10 New Projects Per Year)

	Optimum	Austere
Steady-State Project	10 per Year	10 per Year
Steady-State Budget	$200 MEG	$200 MEG
Investment Before Output	$320 MEG	$615 MEG
Output at 6 Years	30 Completed	10 Completed
Projects Being Managed at 6 Years	40 per Year	60 per Year
Total Cost at 6 Years	$890 MEG	$695 MEG

- $195 MEG difference between total investment at 6 years equates to 20 more completions and 2 years of obsolescence in technology.
- The $195 MEG difference also represents the cost of completing the extra 20 "pipeline" projects being managed in the austere case (i.e., 30 completions will still cost the same).

Figure 8. Serendipity Factor



tive is the existence of what may be called the serendipity factor. This postulates that the probability of identifying secondary fallout technology of possible great significance is enhanced by pursuing a broad spectrum of technology, and that by limiting the spectrum of effort, such identification is also limited, with possible loss of opportunity. This viewpoint initially appears reasonable, but given two assumptions, does not withstand scrutiny. The first assumption is that serendipity is unpredictable, but is most likely event-triggered; that is, any fallout technology will result from scheduled work. The second is that, whether pursuing an optimum or an austere schedule, the sequence of work should be similar in scope and approach.

Figure 8 illustrates the situation of two programs being pursued sequentially on an optimum basis as compared to the same programs being pursued concurrently on an austere basis. Because the budget ceiling is the same in each case, the concurrent programs take twice as long as the sequential programs. If serendipity is produced throughout these programs, it is obvious that program A produces it sooner and program B produces it later under the optimum approach as compared to the concurrent approach. The net effect is that there is no difference in the rate of serendipity fallout per unit of time. In the sequential case, half is accelerated and half is delayed by design; in the other, a similar acceleration and delay pattern is produced, but in reverse order in that program A takes longer and program B starts sooner, but the end result is the same. To argue which will produce the most significant serendipity sooner requires divining powers and is really academic.

In other words, just as one can't buy more program completions, one can't buy more serendipity with a fixed budget; and to use such an argument to justify an emphasis on activity is an expensive (in terms of time and management resources) and uncertain proposition. The serendipity factor should be only one consideration in selecting programs to elevate to advanced development. It might be employed to assess the potential to produce fallout technology, but should not be used to justify an across-the-board pursuit of more programs.

The preceding discussion illustrates that the argument of broadened coverage is, at best, a weak justification for austere schedules and more programs. Besides introducing longer schedules, such coverage requires larger management structures and produces no more completed technology.

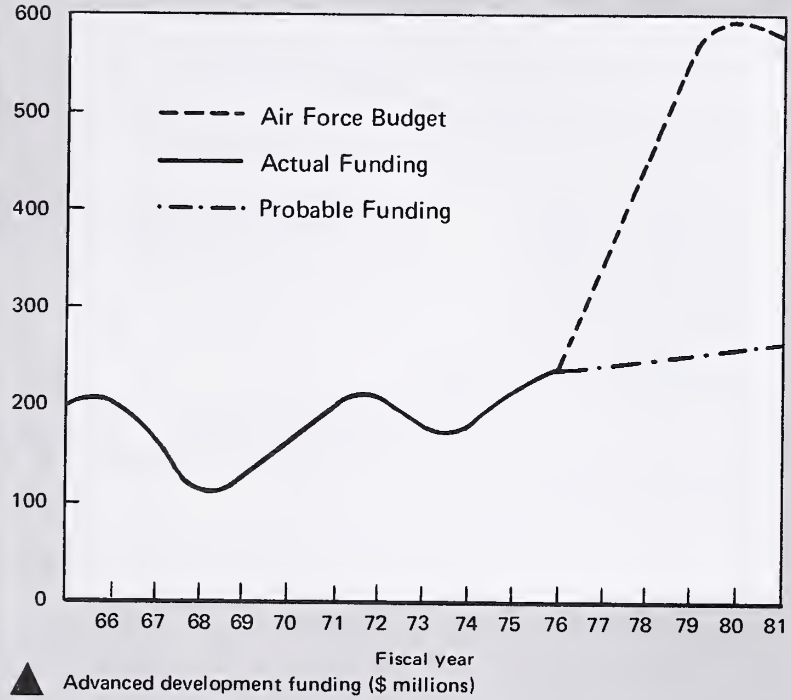
By now the reader might be asking, "What is the relevance of all this to the real world?" The answer is that current planning for this technology-oriented area of advanced development has tended to adopt the broad-front approach rather than the optimum schedule approach, and will soon be facing the reality of a bow wave crunch. Figure 9 shows a 10-year history of actual funding of this area, with a projection of required funding for those programs planned and already implemented. If the 10-year trend of actual funding has any relationship to the probable out-year funding (as assumed by the "probable funding" extrapolation), then it is obvious that requirements exceed funding by nearly 2 to 1.

The similarity between this situation and the comparison in Figure 4 is directly applicable, and major adjustments must be faced in the near term. Such adjustments will not be easy to accommodate, because the change required is more than just fiscal. As noted in Figure 4, the austere program accommodates three times as many active projects as the optimum within-ceiling program (120 versus 40), and twice as many as the corollary case in Figure 6 which could also be considered within ceiling. It is thus apparent that the bow wave of Figure 9 reflects the existence of an excessive number of projects.

Figure 10 on p. 56 summarizes the impact of such a situation on management actions. Some overprogramming for outyears is certainly appropriate to provide flexibility of choice, but a 2- or 3-to-1 ratio is clearly too much. An educated guess would call for about 20 percent overprogramming, as this would permit 2 to 3 new starts to be considered for every one that could be accommodated. Withdrawing to this level will be a rough row to hoe, but will inevitably have to be done to preclude further aggravation of the situation.

There is no pretense that one could ever achieve the ideal programming posture suggested here. Practical events will always dictate some compromise. Technical problems, for example, could force schedule slippages or cost increases which would impact the overall balance. Unless additional funds were provided, schedule and funding adjustments would have to be made. However, to the extent that such adjustments were dictated by technical considerations rather than fiscal maneuverings, a cost-effective program could still be achieved. Even in this case, the existence of a planned management reserve for just such situations could reduce or eliminate the need for across-the-board adjustments.

Figure 9. Advanced Development Technology Funding



A key consideration to keep in mind is that true progress depends on both initiating new technological efforts and obtaining payoffs or conclusions from old efforts. If programming actions preclude new efforts or delay completions in any year, then progress will have been postponed that year.

Conclusion

All of the discussions that have been presented thus far make it possible and appropriate, at this point, to draw some fundamental conclusions.

Maintaining a broad base of technological effort, for example, is vital, but it is the function of exploratory development, not advanced development. An actual increase in technological coverage can be achieved with a level overall budget only by limiting the scope of programs through careful planning of the development approach and objective (that is, reducing the cost per program).

Steady-state budget requirements are dictated by the total cost of programs initiated, not the number of programs pursued, their start-up fund level, or their schedule. Stretching schedules increases the number of programs being pursued and managed, but does not increase the rate of technological production or reduce the steady-state requirement. It does introduce obsolescence.

When program costs and schedules can be forecast with reasonable accuracy, the most technology per dollar and unit

Figure 10. Impact of Bow Wave

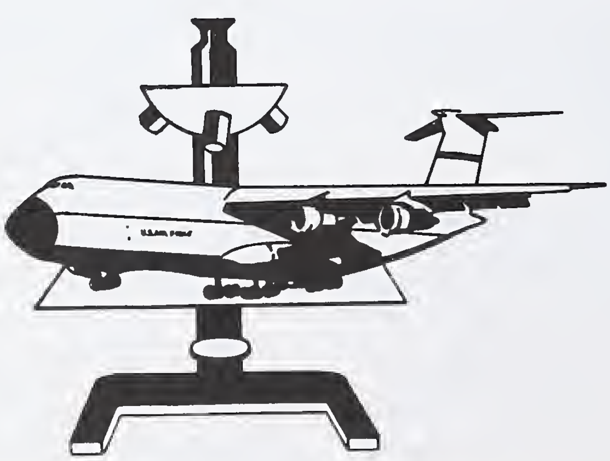
- Project Offices (Air Force & Contractor) Staffed for an Assumed Level of Support Based on the 5-Year Defense Program and a Program Objective Memorandum
- Development Efforts Tuned to Bow-Wave Support Level
  - -- Test Arrangements
  - -- Manpower Actions
  - -- Fabrication Efforts
  - -- Facility Utilization
  - -- Priority Allocations
  - -- Investments
  - -- Paperwork & Documentation
  - -- Overhead
- Appropriate For Those That Go -- A Waste of Time and Resources For Those That Can't Fit

of time results from pursuing optimum development schedules, which reduce required management structures and associated redundant planning activities. In an era when pressures exist to reduce top-heavy management positions, this is increasingly significant.

The preceding conclusions lead logically, then, to a series of recommendations designed to impart order and balance to the system.

Programs, for example, that have ill-defined end products, schedules, or costs should be constrained to exploratory development, and this area should support a broad base of technological activity.

Advanced development, on the other hand, should be reserved for programs with definable end products, schedules, and costs. Programs should not be introduced into advanced development until they are assured of out-year funding and support commensurate with pursuit at their optimum and most cost-effective pace. Providing this funding and support may in some cases necessitate the termination of other programs. Consideration should be given to establishing a management funding reserve to compensate for unplanned cost growths in lieu of across-the-board adjustments.



Finally, programs should be planned to limit their content and duration to the minimum needed to satisfy the objectives, and those objectives, in turn, should be the minimum required to bring the technology to systems application. The consequence of not heeding the above recommendations is to become entrapped in what may be referred to as the stretch-out merry-go-round, which says:

> *More programs than funding can support lead to→ schedule stretch-outs which create→higher steady-state requirements which are→ incompatible with low budgets and dictate→program cancellations justified because of→no progress or obsolescence, thereby making room→for the backlog of new programs which→ because of the low budget will have schedule stretch-outs which create→higher steady-state requirements which are→. . . .*

All of this eventually will contribute to a poor reputation and credibility record.

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Government-Contractor Adversarial Relationships

Ultimately, the government-contractor relationships may determine the success or demise of a program.

The relationship that exists between the government and the contractor is an aspect of weapon systems acquisition that can easily be taken for granted. In the minds of many participants, particularly those representing the government, the government-contractor relationship is viewed as an inconsequential result of the acquisition process rather than a causative factor within the process.

The government-contractor relationship is more than a by-product, however; it is a significant aspect of the multifaceted process of weapons acquisition. Further, it can have a pronounced effect on costs, schedules, technical performance, and ultimately, the success or demise of a program.

Government-contractor relationships can be described as extending along a continuum. At one extreme the relationship may be cooperative, amicable, and perhaps permissive; at the other, it may be hostile, legalistic, acrimonious, and marked by distrust. All too often, government-contractor relationships reach a point at which the two institutions—and perhaps more important, the individuals involved—regard each other as adversaries.

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In addressing the subject of adversarial relationships, two assumptions should be noted. The first is that government contractors have the right to operate as profit-oriented businesses; the second, that a degree of conflict between the contractor (seller) and the government (buyer) is to be expected.

These are reasonable postulates. In a capitalistic system, the contractor is expected to make every attempt to realize a profit; by the same token, the government is bound to do everything possible to reduce costs. In the long run, the ensuing conflict should produce a healthy buyer-seller relationship. As one author points out:

> *. . . the goal of management is not harmony and cooperation—it is effective goal attainment! Elimination of conflict is not realistic in complex organizations, nor would such elimination be desirable. . . .*[1]

To explore the adversarial aspects of the government-contractor relationship, one must:

- Differentiate between specific DoD policy and actual practice.
- Identify and analyze the causes behind the adversarial relationship.
- Recognize developing trends.

Perhaps due to the oligopsonistic character

[1] *Stephen P. Robbins,* Managing Organizational Conflict—A Nontraditional Approach *(Englewood Cliffs, NJ: Prentice-Hall, 1974), p. 19.*

of the defense market, government officials sometimes tend to ignore the importance of the relationship with contractors. As agents of the single buyer (or one of few buyers) dealing with multiple sellers, and thus the ones who make the demands, these officials have been able to disregard the importance of their contractor relationship.

Contractors, on the other hand, are understandably concerned with the adversarial aspect of their business. The National Security Industrial Association, for example, recently stressed the "need to improve the credibility of the DoD procurement process . . . and strengthen the mutual trust and respect between DoD and industry."[2] As stated by an industry representative, ". . . the adversarial nature of the relationship between DoD and the defense industry is more detrimental to productivity than it is beneficial."[3]

An investigation of current defense policies concerning adversarial relationships with contractors suggested that no formal policy exists.[4] A careful search of procurement regulations and DoD directives concerning the acquisition process produced no reference to adversarial relationships. Discussions with procurement officials at departmental and major command levels indicated a general consensus concerning what constituted the "right" relationship. This was loosely described as a "formal, arms length, businesslike" approach. However, this concept did not stem from any formal guidance or conscious effort to define the relationship. The implication is that the subject has not been generally recognized by government officials as one that may impede the weapons acquisition process.

The importance of developing a good relationship has been recognized in at least one of the subsets of the acquisition process. Speaking specifically of the negotiation process, the *Armed Services Procurement Manual for Contract Pricing* states:

> *Successful negotiation demands that you establish and maintain sound, cooperative and mutually respectful relationships with the contractors. Merchandise can't be sold in an atmosphere of distrust and deception . . .*[5]

It should be emphasized that the adversarial relationship may span the entire life of a program. The relationship encountered during negotiation is only one aspect of the ongoing government-contractor relationship. In fact, in light of the artificial and sometimes theatrical relationships that are sometimes employed by both the government and industry as a negotiation technique, the relationship encountered during that brief period can effectively be disregarded.

One government official expressed surprise at the idea that an adversarial relationship might exist or have a detrimental effect on the acquisition process. Another acknowledged that it might exist in some instances, but maintained that most of the burden of guilt lay with the contractor.

In contrast to these opinions are the findings of the recent Profit '76 procurement personnel opinion survey conducted as part of a DoD-sponsored study to identify policy revisions that would better motivate defense contractors.[6] The survey analyzed the results of 200 questionnaires mailed to defense procurement personnel (see Figure). One conclusion drawn from the responses was that:

> *Obviously the respondents view the defense contractors as an adversary who must be managed and/or controlled at the bargaining table. These attitudes may pose a difficult hurdle in trying to reshape procurement policy to new or different objectives.*[7]

Opinions drawn from contractor personnel reinforced the conclusions already formulated about the effects of the adversarial relationship.

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[2] *J. M. Lyle, President, National Security Industrial Association, personal letter to William P. Clements, Jr., Deputy Secretary of Defense, April 18, 1975.*

[3] *Paul R. Siconolfi, "The Adversarial Relationship Between DoD and the Defense Industry: Is It an Aid or an Impediment to Productivity?" Report Number PMC 76–1, Defense Systems Management College, Fort Belvoir, VA, 1976.*

[4] *The investigation of current defense policies and search of procurement regulations was conducted by the author from August to October 1976. Discussions with procurement officials were also conducted by the author during that same period.*

[5] *ASPM Number 1 (Chicago: Commerce Clearing House, 1975), p. 7A25.*

[6] *Coopers & Lybrand,* Profit '76 Procurement Personnel Opinion Survey, *vol. 1 (Washington, DC: Coopers & Lybrand, 1976).*

[7] *Ibid., p. 20.*

Profit '76 Procurement Personnel Opinion Survey

Sample Assertions	Agree	Disagree
Contractors would not cooperate with contracting officials to make this program (DPC 107) a success.	45%	5%
Contractors include a "fudge factor" in their proposals to allow the government to negotiate the price downward.	48%	7%
As part of a long-range marketing strategy, contractors will bid low on competitive procurements, knowing that they will lose money in the long run.	68%	12%

As an example, a recent study by an industry representative at the Defense Systems Management College quoted numerous statements from his contemporaries indicating that this type of relationship is a widespread impediment to systems acquisition.[8] The study also suggested that the adversarial relationship encompassed much more than just the procurement and cost/price areas of programs. It was believed to be a significant aspect of the technical, interpersonal, legal, and other areas that constitute the broad spectrum of government-contractor relations.

The prevalence of the adversarial relationship was also substantiated in a recent study conducted by the Conference Board to ascertain the financial community's perspective of the defense industry.[9] In the view of corporate debt financers, according to the study, the climate of doing business with DoD has a number of negative aspects. Life insurance companies, for example, felt that defense contractors were seriously hampered by attitudes within the Department. The unmistakable message again was that there is a prevailing adversarial relationship between the government and many defense contractors.

Problem Analyzed

In their definitive analysis of the weapons acquisition process, authors Peck and Scherer pointed out one of the basic reasons for conflict between buyer and seller:

> *It is generally assumed that a major objective of contractors is to maximize profits, presumably by maximizing the "price" stated in a contract, and that these profit maximization efforts conflict with the government's goal of minimizing weapons costs.*[10]

The Profit '76 survey indicated that procurement officials still consider it their specific duty to ensure that contractor's profits are kept at a minimum. By contrast, the contractor's actual profit is typically only 4.7 percent of the total contract price.[11] Perhaps a disproportionate amount of government attention is focused on this single aspect of pricing.

A second difficulty lies in the nature of the procurement system. The guidelines for doing business with DoD are extremely complicated and place a heavy administrative burden on the contractor. The entire umbrella of government procurement is not one under which it is easy to build a good rapport between buyer and seller. Grayson Merrill warns defense managers that they must be prepared to cope with the following conditions:

> *The presence of contract and project managers whose decisions in contract administration are inhibited by the extensive documentation, multiple reviews, and critical postmortem scrutiny they involve.*
>
> *. . . constant turnover of career military personnel in key procurement positions,*

[8] *Siconolfi, pp. 28–30.*

[9] *James K. Brown and George S. Stothoff,* The Defense Industry: Some Perspectives from the Financial Community *(New York: The Conference Board, 1976), p. 26.*

[10] *Merton J. Peck and Frederic M. Scherer,* The Weapons Acquisition Process: An Economic Analysis *(Boston, Harvard University, 1962), p. 457.*

[11] *An average profit on fixed-price contracts of 4.7 percent was derived by dividing the profit before taxes by sales for a sample of 61 defense contractors. This was determined for a 5-year period. The average profit for cost contracts was 4.5 percent. The corresponding profit for commercial profit centers was 17.1 percent. Source: Briefing on Profit '76 presented at National Contract Management Association meeting, Arlington, VA, September 13, 1976.*

which inhibits continuity and emphasizes the need for documenting decisions.

. . . surveillance of company operational practice, which has no counterpart in usual business. This is always well-intended, but sometimes conducted by incompetent personnel whose recommendations for improvement are untimely, if not impractical.[12]

Merrill, a retired naval officer, also has favorable comments concerning the defense procurement system. However, the point is made that the system is a difficult one in which to operate.

It should not be concluded that difficulties in government-contractor relations all stem from the government, for both sides have contributed to the problem. One potential source of friction lies in the questionable marketing practices of some contractors. An example is the recent modification of a widely used military aircraft. The airplane manufacturer developed the modification and then conducted an intense campaign directed at Congress and key DoD officials. The company also informally quoted an estimate of the cost of the modification. Eventually, the modification and the associated cost were well fixed in the minds of all concerned. The program was endorsed by Congress, and the Air Force proceeded with the effort. However, when a formal offer was made, the price had risen sharply. The Air Force then had no choice but to request additional money. In the eyes of Congressmen, who recalled the company's marketing effort, it appeared that the first thing the Air Force had done was to overrun the program. The result was that the Air Force was forced into an embarrassing position and perhaps understandably became an adversary of the contractor.

Functional Orientation

Another source of difficulty pervading the defense acquisition process is the functional orientation found within the acquisition system. The complexity of systems acquisition demands that individuals from a number of different functional areas contribute to the process. The specialists involved may be assigned to the program office, or they may be in functional organizations assigned the responsibility for providing support to a program. In either case, individuals tend to retain their functional orientation and thus contribute to a suboptimization within the program.

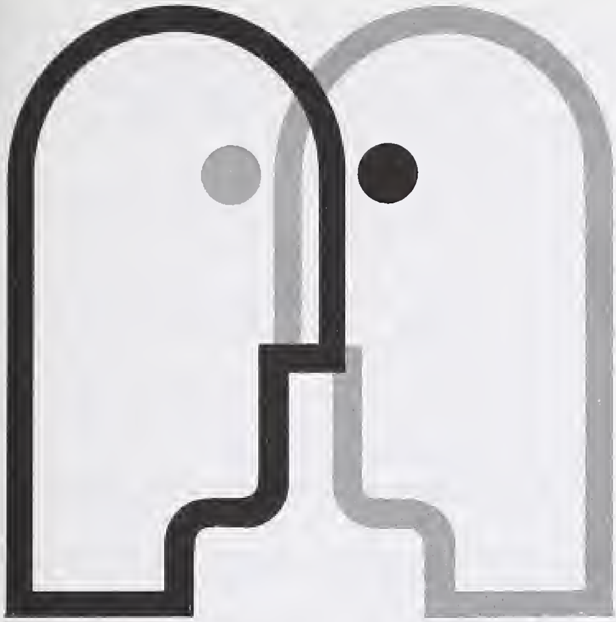
As an example, price analysts are evaluated on their depth of analysis of a proposal. Their objective is to identify the greatest number of areas and the largest dollar amount where the proposed price can be questioned. The procurement contracting officer also has an objective to meet as he attempts to negotiate the lowest price for the government. Often he is evaluated, informally or otherwise, by the size of the concessions he is able to wrest from the contractor. Engineering personnel, because they are charged with the technical performance of the system, may attempt to maintain that performance at the expense of costs and schedule.

Each individual, then, tends to look at the systems from the perspective of his own areas of responsibility. The program manager, who is charged with overseeing the trade-offs between competing objectives, is not always able to accomplish these trade-offs successfully. In many cases, he may not have direct authority over his functional specialists. The result of these competing and conflicting objectives is that it is easy for each individual to fall into the role of adversary to ensure that his particular objectives are met.

A case in point occurs when a functional specialist, in his well-intentioned but narrow focus, repeatedly requires the contractor to respond with unnecessary technical depth or cost justification. The added manpower costs associated with answering these demands may well outweigh the value of the particular item or issue in question. Further, while the adversaries are battling, program progress may come to a halt.

There are a number of practices that can cause programs to be underbid. The first commonly occurs when a contractor believes he will have little chance of gaining future contracts unless he wins the initial contract. This creates a "win at any cost" philosophy and can result in a contractor seriously underbidding a contract. Another is the situation where a company is most immediately concerned with providing revenue to cover its fixed costs. The re-

[12] *Grayson Merrill,* Managing A Defense Company *(New York: Exposition Press, 1972), p. 101.*



sult is that the company bids low enough to attain only this limited goal. This can happen when the company learns the dollar limit for a contract and bids accordingly.[13]

Both of the foregoing factors lead to "buy-in" situations, with the inevitable result that the program is underpriced and both parties eventually become adversaries.

Underlying Causes

The causes of adversarial relationships thus far described have resulted from more fundamental problems affecting the weapons acquisition process. The rising costs of military weapons, for example, have become very visible to the public. Because of inflation, the increasing complexity of weapon systems, and the manner in which cost overruns are presented to the public, many Americans have developed a negative view of defense spending. This, coupled with what appears to have become a fundamental public attitude of distrust of the military-industrial complex, has made practically all defense spending suspect.

By the very nature of the American political system, Congressional attitudes tend to reflect the attitudes of constituents, and perhaps vice versa. There are also many fundamental disagreements in Congress concerning the application of the country's fiscal resources. Further, there are many Congressmen who are sincerely concerned with reducing federal spending not only in defense, but in all areas. These factors combine to form an environment where any acquisition problem can produce intense criticism from Congress.

Additionally, because of the intense pressure generated to hold down the costs of weapon systems, there appears to be a tendency to fund programs inadequately. In a letter to the Deputy Secretary of Defense, the National Security Industrial Association discussed inadequate funding practices by procuring agencies in the following terms:

> *The funding which is known to be available for a particular program may, for various reasons, be less than that which is required in order to perform the work properly. Such funding inadequacies may be due to "downward bias" (the desire, conscious or otherwise, on the part of the agency to look optimistically at costs so as to better sell the program to Congress, OMB, etc.).*[14]

When this occurs, the program inevitably develops financial difficulties and the program manager must take a hard line with the contractor.

The existence of this cause and effect relationship is emphasized in a study by the Logistics Management Institute. The fundamental problem, according to industry sources interviewed by the Institute, is an overoptimism that permeates the whole acquisition process:

> *It starts, they maintained, with understated estimates of program costs by the Services, sometimes in response to pressures put upon them by OSD. It continues with pressure put on contractors to respond with proposals to meet the Service objective. It ends, they said, with a blurring of responsibility for the resulting cost-performance problems and excessively adversary relationships.*[15]

The point is well taken, although the conclusion

[13] *This list of practices was drawn principally from a report prepared by the National Security Industrial Association and forwarded to Deputy Secretary of Defense Clements by J. M. Lyle, April 18, 1975.*

[14] *J. M. Lyle, President, National Security Industrial Association, letter to Deputy Secretary of Defense Clements, April 18, 1975, p. 5.*

[15] *Logistics Management Institute, "The DoD-Contractor Relationship," Task 71-16, Washington, DC, November 1973, p. 60.*

should not be drawn that underbidding is exclusively the result of overoptimism.

In summary, an underlying cause behind adversarial relationships is the prevailing public attitude concerning defense spending and defense cost overruns. This attitude is reflected in Congress and in many instances even reinforced by Congress. DoD then reacts with an intense effort to control costs. Ultimately, these pressures are focused on the program manager and his supporting personnel, who are left little maneuvering room in which to manage a program effectively. The solution chosen in many cases is to face the contractor as an adversary who can be allowed no quarter.

At the same time, contractors feel compelled to resort to the practices described earlier. The result, again, is the eventual collision of forces between a contractor who is short of revenue and a program manager who must keep his program within its parameters.

Trends

In analyzing the factors that lead to adversarial relationships, two trends become apparent. Suspicion concerning the military-industrial complex and increased resistance to defense spending are significant factors in weapon systems acquisition. Associated with these is the increasing pressure to allocate national resources to nondefense areas; in particular, the pressure to increase public spending in the social-services sector. As these pressures build, the public outcry over high weaponry costs and cost overruns will increase. An inevitable consequence must be increased efforts to hold down costs. The result will be an accelerated trend towards increasingly adversarial relationships.

The second trend hinges upon a change that is evolving in defense program management organizations. In order to meet other goals, such as a more effective use of personnel resources, there is a tendency, at least in some organizations, toward dissolving the traditional program office structure. Functional specialists such as engineers, procurement personnel, and program controllers are being removed from the control of the program manager and placed under functional directors. As these personnel no longer answer directly to the program manager, there will be increased functional orientation in program management and less ability on the part of the program manager to control the adversarial relationships that can result.

Of the many conclusions that can be drawn from all that has gone before, the following are, perhaps, the most significant:

- There is no specific DoD policy concerning government-contractor adversarial relationships.
- Adversarial relationships spring, in part, from a number of practices that result in underpricing contracts.
- They may also result from the type of organizational structure employed in defense systems program management.
- Adversarial relationships, which can be expected to increase in the immediate future, are detrimental to the interests of both government and contractors.

These conclusions lead inevitably to the recommendation that DoD recognize the detrimental effects of adversarial relationships and issue a firm position statement against this phenomenon. Further, it is recommended that defense acquisition agencies recognize the inherent risk in reducing the program manager's authority to control government-contractor relationships that develop.

This is not to suggest that DoD soften its position against excessive costs or develop a policy of acquiescence towards contractor demands. Rather, both government and contractor alike must make a conscious effort to develop a rapport located near the middle of the relationship continuum. If this is done, the losses in time and resources that accompany adversarial relationships can be avoided.

The best, and ultimately the most effective relationship, is one which reflects neither permissiveness nor asperity. It is a cooperative, goal-oriented relationship based on integrity and mutual respect. DMJ

LIEUTENANT COLONEL MICHAEL B. PATTERSON, USAF, is Assistant Deputy for Business Management, Deputy for Surveillance and Navigation Systems, Electronic Systems Division, Air Force Systems Command.

He has had assignments as a Deputy System Program Director and has also served in test and procurement positions.

Colonel Patterson is a graduate of the Armed Forces Staff College and the Defense Systems Management College. He has an M.B.A. and Ph.D. in Business Administration.

Government Engineers in a Major Prime Contractor's Plant: How Real is the Need?

A DCAS Plant Representative proposes a major realignment of work priorities for plant cognizance teams.

One of the most significant functions of government engineers in a major prime contractor's facility is to achieve cost avoidance in weapons systems procurement while ensuring that the contractor's engineering system provides a good product. But as currently declaimed by many traditional engineers and as conceived by many senior managers in the systems program and contract administration fields, the general orientation and priority of the engineers' tasks are producing neither cost avoidance nor system quality. While this is a negative statement, it is not meant to be negative toward working engineers.

by Lt. Col. Edward C. Solomon, USAF
Commander
Contract Administration Services Plant Representative Office
McDonnell Douglas Astronautics Company-West
Huntington Beach, CA

Traditionally, government engineering tasks in a contractor's plant were oriented toward hardware and things that stem from hardware. Engineers were the "eyes and ears" of the procuring agency, to and from which they relayed technical status information; moreover, they ensured that contractor engineering change proposals received the proper technical classification. Occasionally they also participated in hardware decisions when configuration changes were suggested. The extent of this involvement generally depended on the staffing of the Systems Program Office and the number of government engineers in the plant.

Changing Work Priorities

Today there is a better understanding of those government engineering surveillance tasks which can contribute to contractor cost avoidance and product improvement. Excellence in management by the contractor of his systems, resources, and facilities is a basic ele-

ment in avoiding unnecessary costs and improving the product. But this entails a reorientation in the priority of the surveillance tasks of in-plant government engineers. Four developments in aerospace procurement have helped accelerate the change in government engineer work priorities.

- More sophisticated financial information reporting systems required of prime contractors, such as Cost/Schedule Control Systems Criteria. C/SCSC and similar financial management tools provide information much sooner than before, making it possible to focus rapidly on the financial anomalies of contracts. Thus, the need for much of the "eyes and ears" activity of the in-plant engineer is reduced, because the "out of tolerance" cost item elicited by C/SCSC immediately alerts the Systems Program Office to an underlying technical problem.
- Critical and massive program fund reductions which compel the procuring agency to negotiate major hardware changes. No longer can a procuring agency parcel out dollars for significant, independent in-plant negotiations without jeopardizing the total program dollar picture.
- Technology that has become so sophisticated that the government plant engineering staff does not have the resources to maintain technical design parity with the contractor. With the myriad of programs now present at major prime contractors' facilities, it would not make sense to attempt to maintain an in-plant capability. The procuring agency technical staff, rather than in-plant engineers, should be executing the technical design review task.
- Reductions of in-plant government engineering staffs in line with government contract administration manpower reductions.

Coping with this changed situation would require priorities to be reestablished in the following order:

—Contractor Engineering System Review.

—Contractor Engineering Resources Review.

—Assistance to the Systems Program Manager on technical matters as mutually negotiated.

The task also includes technical assistance in field pricing efforts. This function must be flexible because the support required will depend on many factors, such as technical staffing of the program and plant offices, complexity of particular programs, and what stage of development the products have reached.

Review of the contractor's design system.

A System Review Proposal

Since the cornerstone of every major aerospace company is its engineering department, the contractor's engineering community is generally the largest or second largest segment of the employee population. Thus, acting as the primary government management analyst, the government engineer must ensure that the contractor's engineering systems mesh into an integrated whole and are reasonably staffed.

"The government in-plant engineering orientation has to be refocused toward ensuring that the contractor has an adequate engineering system and practices satisfactory resources management before the controls can be removed."

Reviewing an engineering system includes evaluating how well engineering mates with other functions, such as quality assurance and manufacturing. And it includes the assessment of all the "ilities," such as reliability and maintainability. The system for the flow of the engineering task to and from subcontractors is also an item for major review, for experience has shown that many contract engineering problems stem from inadequacies in subcontract

integration. Finally, systems review is very helpful to the Systems Program Manager.

Systems review combines deficiency-preventive medicine with a strong dose of resource management visibility, since systems review also provides insight into contractor management structures. The in-plant government engineering force is the only government entity with a complete view of the contractor's design system. This is because most contractors are geared to working on many programs simultaneously, and not all program offices utilize the contractor's entire engineering system. Review of the contractor's design system by government in-plant engineers allows the Systems Program Manager to concentrate on directly monitoring both the contractor's approach to the technical problem being pondered and the engineering resources allocated to its solution.

"At the heart of the matter is the contractor's belief that the in-plant government technical community does not have the capability to judge the adequacy of the contractor's engineering systems management or technical progress on contract matters."

(Government in-plant price analysts are also available to assist the Program Manager in this.)

Effects of New Proposal

Following the realigned priorities, the in-plant engineer would devote himself to analyzing the contractor's use of direct and indirect engineering resources. His in-depth reviews would make it possible to eliminate the big cost surprises that have sometimes been caused by indirect engineering charges. On the contractor's side of the coin, the systems review method would permit government procurement personnel to disengage themselves more from contractor operations, a goal long and strongly sought by the aerospace industry.

Engineering Systems Review should also encompass each particular contractor's management of Independent Research and Development within the terms negotiated by the cognizant government agency. (IR&D matters may seem to belong exclusively to auditors and contract specialists, but technical analysis cannot be accomplished satisfactorily by their disciplines, and technical analysis is absolutely imperative here.) Actually, IR&D endeavor falls into two stages. Initially, the in-plant engineer provides technical assistance to the IR&D negotiator by scrutinizing the contractor's annual IR&D proposal, the objective being to recommend the elimination of items which do not have potential Department of Defense applications. The second stage begins when the contractor becomes engaged in the IR&D as negotiated. In this phase, the in-plant engineering staff monitors the contractor's classification of IR&D expenditures to ensure that proper differentiation is made between IR&D and other expenditures. This is a highly critical process, for IR&D expenditures over the negotiated ceilings are not chargeable to general overhead costs; this means the contractor cannot allocate them to government contracts, and thus they become a drain on the contractor's profits.

Review of Resources Critical

Contractor Resources Review, which includes contractor management of manpower and facilities resources, is also a critical in-plant task for government contract administrators. Generally, given the dollars, most prime defense contractors can do an adequate technical job. But their management of the resources for that effort often does not rate equally high. This is especially true in times of reduced business activity, when contractors exert great effort to retain an engineering staff beyond what realistic future business projections indicate will be needed. Review of the contractor's resources by the government in-plant team can help determine reasonable staffing levels for contractor technical personnel. Such review also produces a key input when it comes time for the Administrative Contracting Officer at the plant to negotiate direct and indirect labor rates (forward pricing rates). These labor rates simplify the job of the Procuring Contracting Officer in that the PCO then doesn't have to negotiate labor rates each time he awards a new contract.

More than 60 percent of government contract dollars are spent on overhead items when sub-

contract indirect expense is also considered. Some prime contractors have cosmetically reduced this in order to appear "lean and mean" in their proposals, rearranging the way certain activities are charged; but the work actually done is overhead expense. Analysis of indirect dollars shows that they permeate all contracts and offer the greatest opportunity for savings.

Prime areas for reduction of overhead costs are IR&D and contractor engineering resources. Another fruitful domain is the direct engineering man-hours contained in contractor cost/price proposals.

The first two tasks in the aforementioned priority listing, Contractor Engineering Systems Review and Contractor Engineering Resources Review, lack glamor, are tedious, and demand both technical intellect and skills in interpersonal relationships. Considering where the dollars are in prime contractor defense contracts, it is clear that this is where a good portion of the government in-plant engineering activity should be. The outlined prioritizing of tasks would contribute to disengagement during contract performance, a goal sought by contractors and espoused by industry associations. But the necessity for engagement is required as long as government contracts continue to be mainly of the cost and fixed-price incentive variety (in dollars).

Greater Disengagement Possible

Some progress has been made toward disengagement. Contractor Purchasing Systems Reviews have been a part of government contract administration for several years; yet they have provided only a limited means of disengagement. Their deficiency lies in the fact that CPSR's portray the contractor system at a given point in time, and the in-plant review performed, although extensive, does not include subcontractor facilities. Experience has shown that in most cases prime management of subcontractors does not always match the prime contractor's approved system as set forth in the price procedures, especially in engineering and quality assurance. The only way that systems can be adequately reviewed is by field surveillance of actual events on a continuing sampling basis; hence the need for a more refined way to do subcontract review.

A few years ago, Air Force Lieutenant General Donald G. Nunn, then Commander of the Air Force Contract Management Division, initiated a functional systems approach to contract administration which today is known as the Contract Management Systems Evaluation Program. Each discipline of the contractor (e.g., contracts, engineering, manufacturing, quality, subcontracts) was subjected to review against a standard, and an appropriate evaluation of performance was made. The initial reviews were sometimes painful for both the government and the contractor, but the CMSEP concept is the basis for greater disengagement once the initial process is completed.

Recent defense industry association attempts to eliminate CMSEP as administratively wasteful are short-sighted. CMSEP makes less government involvement in daily operations possible, especially in engineering areas. Systems sampling can be initiated once the contractor system has been fully reviewed and is deemed effective, after which only changes to the system need be fully investigated. This would permit greater disengagement and allow the contractor to operate with less one-on-one government involvement on a daily basis. Reduction in resources is then possible on both sides.

Another uneven approach to disengagement can be seen in recent attempts by aerospace contractor associations to convince DoD to rearrange responsibilities for Armed Services Procurement Regulation 1–406 engineering tasks between the procuring agency and the

contract administration activity. The industry proposal would remove from the Administrative Contracting Officer and the in-plant government engineer all power to review the contractor's engineering resources and systems. Instead, oversight of these items would be placed with the procuring agency. In actuality, those two engineering elements are best looked at by in-plant engineers. The proposal would also deny to the government the single point it now has for effective management of contract overhead expense; because major prime contractors now perform contracts for several program offices at the same time, the single point would be replaced by many. Shifting the ASPR responsibility from the in-plant engineer would deprive the ACO of insight into a major contractor dollar resource.

The Undercurrent Issue

At the heart of the matter is the contractor's belief that the in-plant government technical community does not have the capability to judge the adequacy of the contractor's engineering systems management or technical progress on contract matters. But the basic capacity is not lacking; rather, the real problem is to define the role of the government engineer adequately, and then to begin the proper orientation of personnel.

Neither does the concept of Contractor Weighted Average Share in cost risk validate eliminating the tasks the government in-plant engineer should continue to do. CWAS has not been the motivator to control indirect costs that it was designed to be, although the concept of disengagement has merit from a resources standpoint on both industry and government fronts. CWAS has probably failed because the presumptions are more theoretical than factual. In reality, many complex systems procurements fitting the ASPR definition of competition and awarded as a fixed-price incentive contract have only marginal risks due to the technical superiority of one or two of the contractors bidding on that particular proposal. Further, in the fixed-price incentive mode, contractors will gladly accept a profit penalty for an overrun as long as it keeps highly qualified technical people on board. This is especially true in today's business environment, where survival is the real motivation. Additionally, once a major program is captured, the theoretical risk of competitors which was present during the competition for the initial contract award is generally nullified. Recent revelations of questionable contractor payments in the foreign commercial arena reinforce the contention that CWAS is less than an optimal solution to disengagement, as commercial business doesn't provide the necessary incentives.

Controls vs. Flexibility

Reduction in resources for both government and industry, coupled with the need for more management flexibility for aerospace contractors in lean business times, requires reductions in contract administration controls and greater flexibility for contractors. However, changes must not sacrifice a measure of cost control and contractor system reliability for the government. Maintaining a strong in-plant engineering role performing the right tasks will help make those changes in that context. The government in-plant engineering orientation has to be refocused toward ensuring that the contractor has an adequate engineering system and practices satisfactory resources management before the controls can be removed. The systems approach by the government can change the control methods. Daily technical operations can then be more disengaged, providing greater contractor flexibility to marshal resources for individual contract effort. DMJ

Acknowledgment: The author wishes to express his gratitude to Lt. Gen. Donald G. Nunn, USAF (Ret.), for his helpful comments and criticisms.

LIEUTENANT COLONEL EDWARD C. SOLOMON, USAF, is currently assigned as Commander of the Defense Logistics Agency's Defense Contract Administration Services Plant Representative Office at McDonnell Douglas Astronautics Company-West.

Lt. Col. Solomon has held numerous procurement positions throughout his career including assignments as a contracting officer, procurement office chief, procurement inspector general, Air Force plant representative, and chief of the procurement policy division at major command headquarters.

Lt. Col. Solomon holds B.A. and M.B.A. degrees from George Washington University. He is also a graduate of the Armed Forces Staff College, the Air Command and Staff College, and the Air War College.

Who's New in DoD

Their decisions will have significant impact on Department of Defense planning and policies. For the most part, however, their names and faces are relatively little known to persons in DoD. In this and succeeding issues of the **Journal,** *brief introductions are offered to the newly appointed managers in the Department of Defense and the Military Departments.*

William J. Perry, the Director of Defense Research and Engineering, was president of ESL, Incorporated, and director of ESL Laboratories, Sunnyvale, California, at the time of his appointment. In addition to his management duties, he engaged in analysis of missile systems and the design of electronic reconnaissance systems.

Prior to establishing ESL in 1964, he spent ten years as director of the Sylvania Electric Products Electronic Defense Laboratories, Mountain View, California.

Dr. Perry, 49, is a charter member of the Defense Intelligence Agency's scientific advisory committee and has served as an advisor to the National Security Council. In the latter capacity, he participated in studies of the missile gap issue in 1960 and of verification problems in strategic arms limitation talks.

He holds B.S. and M.S. degrees from Stanford University and a Ph. D. degree from Pennsylvania State University.

Russell Murray II is the Assistant Secretary of Defense (Program Analysis and Evaluation). When nominated, Mr. Murray was a member of the board of overseers and director of review at the Center for Naval Analysis, Arlington, Virginia. He also was a member of the Chief of Naval Operations executive panel.

From 1950 to 1962 he was associated with the Grumman Aircraft Engineering Corporation, first in the field of guided missile flight test engineering and later in operations analysis.

Mr. Murray, 51, served in the Department of Defense from 1962 to 1969, holding the position of Principal Deputy Assistant Secretary of Defense (Systems Analysis) from 1965 to 1969. From 1969 to 1973, he was director of long-range planning for Pfizer International in New York City.

He holds B.S. and M.S. degrees in aeronautical engineering from the Massachusetts Institute of Technology.

Gerald P. Dineen, the Assistant Secretary of Defense (Communications, Command, Control, and Intelligence) had been director of the Massachusetts Institute of Technology's Lincoln Laboratory since 1970.

He joined Lincoln in 1953 and held managerial positions in information processing and communications before becoming associate director in 1966. He became a professor of electrical engineering at MIT in 1971.

Dr. Dineen, 52, was vice chairman of the scientific advisory committee of the Defense Intelligence Agency from 1966 to 1973; and vice chairman of the Air Force Scientific Board from 1972 to 1975, when he became chairman. He was appointed a member of the technical advisory committee of the Federal Aviation Agency in 1976.

He holds a B.S. degree in mathematics from Queens College, New York, and M.S. and Ph. D. degrees from the University of Wisconsin.

Thomas B. Ross is the Assistant Secretary of Defense (Public Affairs).

Mr. Ross, 47, began his journalism career in 1955 with the International News Service in Atlanta, Georgia. In 1956, he managed the INS bureau in Hartford, Connecticut; and in 1957, he joined the INS Washington bureau, where he was assigned to the Pentagon.

From 1958 to 1977, he was with the Chicago Sun-Times: first, as the newspaper's national security correspondent in Washington; later, as a foreign correspondent; and finally, in 1970, as Washington bureau chief.

Mr. Ross received a B.A. degree in English from Yale University. He is the co-author of three books: "The U-2 Affair," "The Invisible Government," and "The Espionage Establishment."

Deanne C. Siemer is General Counsel of the Department of Defense. When nominated, she was a partner in the law firm of Wilmer, Cutler, and Pickering, which she joined in 1968.

Ms. Siemer worked for the Office of Management and Budget in 1964 and 1965.

While with Wilmer, Cutler, and Pickering, she served as part-time faculty member of the National Institute for Trial Advocacy, part-time faculty member for the University of Buffalo Law School, and lawyer-advisor for a trial practice course at the Harvard Law School.

Ms. Siemer, 36, has served as president of the Harvard Legal Aid Bureau and is a member of the Executive Committee of the Washington Lawyers' Committee for Civil Rights Under Law.

She has received a B.A. degree from George Washington University and an LL. B. degree from the Harvard Law School.

David E. McGiffert was a partner in the Boston law firm of Covington and Burling when he was appointed Assistant Secretary of Defense (International Security Affairs).

He served as Assistant to the Secretary of Defense (Legislative Affairs) from 1962 to 1965 and as Under Secretary of the Army from 1965 to 1969.

From 1953 to 1955 and from 1957 to 1961, Mr. McGiffert was associated with Covington and Burling. During 1965, he was a lecturer in law at the University of Wisconsin.

Mr. McGiffert, 50, was a member of the Defense and Arms Control Study Group of the Democratic Party's Foreign Affairs Task Force from 1974 to 1976.

He holds a B.A. degree from Harvard University and an LL. B. degree from the Harvard Law School.

John P. White of Malibu, California, is the Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics).

At the time of his appointment, Dr. White was senior vice president of the Rand Corporation with responsibility for national security research programs. He joined Rand in 1968 as a research economist, serving later as director of manpower, personnel, and training research; coordinator of transportation research; and vice president for research for the Office of the Secretary of Defense.

Dr. White, 40, received a B.S. degree in industrial and labor relations from Cornell University, an M.A. in economics and public administration from Syracuse University, and a Ph. D. in labor economics from Syracuse.

a few words about...

DoD Approves Revisions

New Directives on Major System Acquisitions

The Department of Defense has approved revisions of DoD Directive 5000.1, "Major System Acquisitions," and DoD Directive 5000.2, "Major System Acquisition Process." The revised directives implement Office of Management and Budget Circular A–109, "Major System Acquisitions," and update DoD policy for management of major systems acquisitions as well as the associated DoD decision-making process. DoD Directive 5000.1, "Acquisition of Major Defense Systems" (December 1975); DoD Instruction 5000.2, "DoD DCP and DSARC" (January 1975); and DoD Directive 5000.25, "DSARC" (January 1975), have been cancelled.

The new directives promulgate two significant additions to major systems acquisition policies and procedures: a restructuring of the front end of the acquisition process, and a move toward decentralized decision making by directing the establishment of service system acquisition review councils.

The restructuring of the front end adds a Milestone–0 decision point. The four key DoD decision points are now identified as:

- Milestone 0: Program Initiation
- Milestone I: Demonstration and Validation
- Milestone II: Full-Scale Engineering Development
- Milestone III: Production and Deployment.

The potential for limiting the number of DSARC reviews through reliance on service secretary and review council management activities can contribute greatly to decentralization of systems acquisition management.

Charters Signed

Three Major Defense Offices Merged Into Two

Secretary of Defense Harold Brown has signed new organization charters which detail the responsibilities and functions assigned to the Director of Defense Research and Engineering and the Assistant Secretary of Defense for Manpower, Reserve Affairs and Logistics.

Responsibility for Department of Defense research, engineering, and acquisition activities will be consolidated under the Director of Defense Research and Engineering, who will serve as the DoD acquisition executive.

The Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics) will be responsible for all functions formerly assigned to the Assistant Secretary of Defense (Manpower and Reserve Affairs). In addition, the functions formerly assigned to the Assistant Secretary of Defense (Installations and Logistics), less the acquisition activities transferred to DDR&E, will be assumed by the ASD (MRA&L).

The position of Assistant Secretary of Defense (Installations and Logistics) is being disestablished.

New Address For DMJ

Concurrent with the realignment of major offices in DoD, responsibility for the *Defense Management Journal* has been transferred from the former Office of the Assistant Secretary of Defense (Installations and Logistics) to the Office of the Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics).

The new mailing address is: *Defense Management Journal*, OASD (MRA&L), Cameron Station, Alexandria, VA 22314.

Recent Publications

Bibliography of Design to Cost Studies. Available without charge to DoD organizations and to defense contractors with written authorization from DoD sponsor. Contact Army Logistics Management Center, ATTN: DLSIE, Fort Lee, VA 23801. Phone: (804) 734-4546; autovon 687-4546.

Hybrid Circuit Data, Winter 76-77, Catalog #MDR-5. A 360-page volume with data on field operation, reliability demonstration test, burn-in, and screening as collected over the past year and analyzed by RAC reliability specialists. Price: $50.00 ($60.00 non-U.S.) prepaid. Contact Reliability Analysis Center, RADC/RBRAC, Griffiss AFB, NY 13441.

Research Program

A university resident research program initiated by the Air Force Systems Command will enable faculty members of institutions of higher learning to conduct research in an Air Force laboratory or serve as research managers in the Air Force Office of Scientific Reseach.

The purpose of the program is to provide an opportunity for qualified faculty members to direct their expertise toward Air Force research and also enhance their own professional development.

Persons interested should contact the Air Force Office of Scientific Research, ATTN: Lt. Col. Deloney, AFSC University Resident Research Program, Building 410, Bolling AFB, Washington, DC 20332. Phone: (202) 767-4148.

Feedback

To the Editor:

In a recent article on "The What's and Why's of Independent Research and Development" (April 1977), Mr. Karl G. Harr, Jr., left the distinct impression that all the major technology advances of the F–16 were founded on company-sponsored research and development.

This is certainly not the case. The electronic flight control system design of the F–16 was founded on Air Force-contracted exploratory development programs performed in the early 1970's under the aegis of Project 680J. These contracts led to a successful flight demonstration of a multichannel analog flight control system which was the principal risk reduction mechanism for this key system on the F–16.

The Department of Defense strongly endorses a healthy IR&D program. Overdrawn advertisement of IR&D contributions will only serve to undermine the legitimate standing of the program.

Bartley P. Osborne, Jr.
Washington, D.C.

To the Editor:

I refer to the article "Orthodox Job Enrichment: A Common Sense Approach to People at Work" by Frederick I. Herzberg (April 1977).

Unfortunately the article contains many claims but no case histories which would illustrate the job enrichment brought about by OJE. In other words, what did the warehouseman, the mechanic, the office worker actually *do* before and after OJE?

I, and other readers probably too, would appreciate it very much if *DMJ* or Professor Herzberg could give us some down-to-earth information.

Henry S. Lax
Mira Loma, CA

Professor Herzberg replied:

Case histories which illustrate job changes can be found in several of the articles listed in the bibliography and footnotes, specifically in "Efficiency in the Military: Cutting Costs with OJE" reprinted in The Managerial Choice: To Be Efficient and To Be Human.

The Defense Management Journal *article emphasized the relationship of OJE to productivity, was limited in length, and therefore could not include this data.*

Research continues, and further articles will be published as results become available, in addition to those now published in public media and in technical reports.

CALENDAR

Event	Date	Place	Contact
Management by Objectives Seminar—for managers with MBO objectives	July 14-15 August 8-9	Houston, TX New York, NY	Heidi E. Kaplan, Dept. 14NR New York Management Center 360 Lexington Ave. New York, NY 10017 (212) 953-7262
Forecasting and Decision Making Seminar—for executives	August 10-11 Oct. 6-7 Dec. 8-9	New York, NY San Francisco, CA Chicago, IL	see Kaplan above
Government Project Management Seminar—for managers generally	August 17-19 Sept. 26-28 Dec. 12-14	Chicago, IL San Francisco, CA New York, NY	see Kaplan above
Statistical Methods—for professionals with reliability problems	August 22-26	Washington, DC	Director, Continuing Engineering Education, George Washington University Washington, DC 20052 (202) 676-6106
Design to Cost—for those with responsibilities in development and production contracts	Sept. 7-9	Washington, DC	see George Washington University above
Managing Management Time—for managers at all levels	Sept. 19-20	Washington, DC	L. Scott Varner/Yolanda Yancey USDA Graduate School 529 14th St., N.W. Washington, DC 20052 (202) 447-3247
Government-Industry Data Exchange Program—for government and industry executives	Oct. 5-7	Costa Mesa, CA	Dennis Starling Datagraphic, Inc. Box 82449, San Diego, CA 92138 (714) 291-9960, Ext. 1266
Procurement Management—for individuals with duties involving systems acquisition or systems management	Oct. 11-14	Washington, DC	Lee J. Breyer/Mary Pruitt see USDA above
Maintenance Management—for engineers and managers with maintenance analysis and planning responsibility	Sept. 14-16	Washington, DC	Center for Continuing Education Virginia Polytechnic Institute and State University Blacksburg, VA 24061 (703) 951-5182

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defense management JOURNAL

Vol. 13, No. 3 July 1977

Scope: The *Defense Management Journal* is an official quarterly publication of the Office of the Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics). The *Journal* highlights DoD policies, programs, progress and problems related to the management of logistics and various other interdisciplinary areas of management such as personnel; procurement; materiel; transportation; administration; research, development, test and evaluation; and other factors impacting on the total defense effort. The *Journal* is a medium for the interchange of ideas and techniques for management improvement through the publication of solicited and selected, unsolicited articles.

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Employees of other governmental agencies should contact their administrative office for consolidation of the agency requirement; the agency should then notify the *Journal* office.

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